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Chapter 1. Introduction

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1.1 Scope and Rationale

Chincoteague National Wildlife Refuge (CNWR) includes 14,032 acres of beach, dune, marsh, and forest habitats stretching over six barrier islands in Virginia: Assateague, Assawoman, Chincoteague (Wildcat Marsh on north tip), Metompkin (northern tip), and Cedar; and 427 acres on Morris Island (located in Assateague Channel between Assateague and Chincoteague Islands) (Figure 1). Approximately 418 acres are located on the Maryland side of Assateague Island. Wallops Island National Wildlife Refuge (WINWR) encompasses 373 acres of forest, shrub, and marsh habitat on the mainland. Both Refuges will be covered in this Habitat Management Plan (HMP).

Chincoteague and Wallops Island NWRs are managed by the U.S. Fish and Wildlife Service as part of the National Wildlife Refuge System (NWRS). The mission of the NWRS is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

This Habitat Management Plan (HMP) is a dynamic working document that provides long-term vision, specific guidance, continuity, and consistency for managing habitat on Chincoteague and Wallops Island NWRs. The contributions of these Refuges to ecosystem and landscape scale wildlife and biodiversity conservation are incorporated into the HMP. It sets a direction for the next 15 years (2010-2025) with reviews every 5 years, and the use of adaptive management to assess and modify management activities as research, monitoring and priorities may require.

1.2 Legal Mandates

Chincoteague NWR was established on May 13, 1943 through acquisition of 8,808 acres under authority of the Migratory Bird Conservation Act. The Assistant Secretary of the Interior determined that FWS ownership of this land was necessary for protection during nesting and migration seasons of all those species of wildlife determined as being of great value as a source of food, or in destroying of injurious insects, or nevertheless in danger of extermination through lack of adequate protection (U.S. District Court 1943). The Migratory Bird Conservation Commission (MBCC) initially approved the Refuge at a meeting on March 25, 1941, acknowledging the importance of Assateague Island important wintering, migrating, and nesting habitat for black ducks, shorebirds, and migratory birds (MBCC 1941). At that time they also approved acquisition of Jerico and Hebron Islands, two small marshes adjacent to Assateague Island, just north of the Virginia boundary in Maryland.

Since 1943, numerous tracts of land have been added to CNWR. All lands have been purchased with money from either the Migratory Bird Conservation Fund or the Land and Water Conservation Fund. Federal title of these lands is acquired to the mean low water line. In 1990 Assawoman and portions of Metompkin Island (1,608.5 acres total) were purchased with Land and Water Conservation Funds, which come from royalties on off-shore oil drilling.

Refuge purposes are taken from enabling legislation and acquisition authorities for a particular refuge and from Congressional legislation affecting the refuge system as a whole. CNWR purposes include: preserving and enhancing endangered species; protecting and enhancing habitat for migratory and non-migratory species; maintaining indigenous species; and, providing

opportunities for wildlife-dependent recreation (CNWR 1993). The Service database (http:refugedata.fws.gov/databases/purposes) lists the following **Refuge Purposes** for CNWR:

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." (16 U.S.C. 715d) (Migratory Bird Conservation Act).

"...suitable for B (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species...(16 U.S.C. 460k-1) "...the Secretary ... may accept and use real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." (16 U.S.C. 460k-2) Refuge Recreations Act (16 U.S.C. 460k-460k-4), as amended.

"... the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..."(16 U.S.C. 3901(b), 100 Stat. 3583 Emergency Wetlands Resources Act of 1986)

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." (16 U.S.C. 742f(a)(4) "... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..."(16 U.S.C. ¤ 742f(b)(1) (Fish and Wildlife Act of 1956)

"... for conservation purposes ..." (7 U.S.C. 2002 (Consolidated Farm and Rural Development Act)

In 1997, Congress passed the landmark National Wildlife Refuge System Improvement Act (NWRSIA) establishing a unifying mission and a wildlife-first mandate for the Refuge System. The NWRSIA affirmed that: refuges are anchors for biodiversity and ecosystem-level conservation; lands and waters of the System are biologically healthy; and refuge lands reflect national and international leadership in habitat management and wildlife conservation.

The NWRSIA also declares that all existing and proposed public uses must be compatible with each **refuge's purposes,** and highlights six priority public uses that each Refuge should evaluate for compatibility. These are wildlife observation, photography, interpretation, environmental education, hunting and fishing. Recreational activities allowed on CNWR are also influenced by portions of Assateague Island being within the Assateague Island National Seashore (AINS).

Recreational use and related development on Assateague Island were authorized under Public Law 85 57, Chincoteague National Wildlife Refuge, Virginia – Bridge and Road, approved on June 17, 1957, that provided for construction of a bridge and road to the Refuge beach as well as recreational facilities "to permit the controlled development of a portion of the seashore of the Chincoteague National Wildlife Refuge, Virginia for recreational purposes." These "easements and other rights" are subject to "such terms and conditions as the Secretary deems appropriate for the adequate protection of the wildlife refuge and other interests of United States."

The 1962 Refuge Recreation Act (16U.S.C. 460K – 460K – 4) expanded the purpose of all refuges to include "… (1) incidental fish and wildlife-oriented recreation development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species…"

On September 21, 1965, the Assateague Island Seashore Act authorized establishment of AINS. The AINS encompasses the Maryland side of Assateague Island and certain beach portions of the Virginia side of Assateague Island. The Act provided that the National Park Service (NPS) manage the Virginia portion for general purposes of public outdoor recreation with the qualification that land and water within the Refuge be administered for purposes under laws and regulations applicable to national wildlife refuges, including administration for public recreation use in accordance with the provisions of the Refuge Recreation Act (P.L. 87-714 (USFWS 1993).

Wallops Island National Wildlife Refuge (WINWR) was created on July 10, 1975 with the transfer of 373 acres of land to the Service from the National Aeronautics and Space Administration (NASA/Goddard Space Flight Center/Wallops Flight Facility). Wallops Island NWR is located entirely in Accomack County, Virginia. The primary purpose for this land transfer was for wildlife conservation and the " . . . particular value in carrying out the national migratory bird management program." (16 U.S.C. 667b-667d).

1.3 Links to Other Plans

This section highlights the important refuge, regional, and national plans that influence current management of resources at Chincoteague and Wallops Island NWRs. All of these documents were used in developing the habitat goals, objectives and strategies for the Chincoteague and Wallops Island Habitat Management Plan.

Refuge Plans

Comprehensive Conservation Plan (CCP)
The 1997 National Wildlife Refuge Improvement Act requires all refuges to complete Comprehensive Conservation Plans by 2012. A CCP is an all-encompassing document that guides all biological and public use actions on the Refuge for a 15-year period. CNWR began its CCP in 2010; pre-planning occurred in 2009. HMPs are often "step-down" plans from the CCP, but can also be prepared prior to or in conjunction with the CCP. This HMP was drafted during the pre-planning phase of the CCP, so that wildlife habitat goals, objectives, and strategies could be incorporated into the CCP.

Chincoteague National Wildlife Refuge Master Plan
Approved in 1993, the Refuge Master Plan was prepared with sufficient detail and public review to be considered a CCP-equivalent (pers. comm. Region 5 Planner 2006). The management actions for Habitat Protection, Wildlife Management, and Natural Resource Studies were reviewed and incorporated as appropriate into this HMP.

Habitat and Species Inventory and Monitoring Plan
The 1993 CNWR Wildlife Inventory Plan describes surveys and protocols to monitor population numbers and trends. The information obtained from these surveys and programs are used to guide management decisions. After the Habitat Management Plan is completed, the inventory and monitoring plan will be revised using the new 2010 format.

Fire Management Plan
The most recent Fire Management Plan for CNWR was completed in 2009. The Fire Management Plan addresses wildland fire events with guidelines on the level of protection needed to ensure personal and public safety, and to protect facilities and resources. Prescribed

fire programs needed to mimic natural processes and manage habitats, and other pertinent portions of the fire management, will be incorporated into this HMP.

Prescribed Fire Plan

A Prescribed Fire Plan is prepared for each prescribed fire on the Refuge as required by policy. The Plan lays out the management objectives for the prescribed fires, specific prescriptions to achieve the objectives, and contingency planning for managing the fire. The most recent prescribed fire plans for the Refuge were prepared in 2009 for the Wash Flats and Fire Management Unit 2 (Refuge impoundments). This HMP includes prescribed fire as a strategy for achieving certain management objectives.

Upland Habitat Management Plan

In 1992 CNWR completed a plan outlining goals, objectives and management actions for 3,440 acres of forest and shrub habitats on Assateague Island. Unfortunately, reductions in staff and changing priorities curtailed implementation of the plan. The Upland Management Plan will be reviewed, and applicable portions incorporated into the HMP.

Annual Habitat Work Plans

Annual Habitat Work Plans (AHWP) review habitat management activities from the previous year, evaluate monitoring programs, and make recommendations for habitat management strategies and prescriptions for the upcoming year. The AHWP incorporates adaptive management practices by evaluating success of management programs on an annual basis. The most recent comprehensive AHWP for Chincoteague Refuge was prepared in January 2006, and a streamlined version is prepared annually. Shorebird and Delmarva fox squirrel reports are prepared annually and semi-annually, respectively. Results summarized in the 2010 Shorebird and 2008 Delmarva fox squirrel reports are incorporated into this HMP. Likewise, information from the 2007-09 Impoundment (Water) Management Plan was reviewed and incorporated as appropriate.

Refuge Hunt Plans and Annual Hunt Program

The Chincoteague and Wallops Island NWR Hunt Plans were prepared in September 2007 and April 2007, respectively. These plans outline population objectives, identify areas to be open for hunting, and describe how the hunts will be administered for big game (i.e., deer, sika elk) and migratory birds. The Annual Hunt Program is a written document detailing specifics of each year's hunt.

Predator Management Plan

The Refuge manages mammalian and certain avian predators to minimize losses to federally species and other ground-nesting birds. An Annual Predator Management Program is prepared each year prior to the nesting season. It evaluates prior years' results and outlines methods for the upcoming year - protective exclosures, trapping, and shooting - to protect nesting species. This Plan is tiered to the Final Environmental Assessment for the Management of Predation Losses to Native Bird Populations on the Barrier and Chesapeake Bay Islands and Coastal Areas of the Commonwealth of Virginia, prepared by USDA Wildlife Service in 2005.

Biological Opinions and Biological Evaluations

Several Biological Opinions (BOs) prepared by the USFWS Virginia Ecological Services Field Office in Gloucester, VA spell out Terms and Conditions and Conservation Recommendations for various management activities on CNWR. The most comprehensive and detailed one is the 2008 Biological Opinion for Public Recreational Beach Use (USFWS 2008c). This BO addresses the timing, location, and types of beach use permitted in areas that harbor piping plover, sea

turtles and seabeach amaranth. It also requires specific monitoring and protective measures. Elements of the BO will be incorporated into the HMP. Biological Evaluations prepared by staff under Section 7 of the Endangered Species Act (and concurred by USFWS Endangered Species Offices in VA and MD) also set management guidance for other activities in Delmarva fox squirrel habitat.

Refuge Compatibility Determinations (CDs)
CDs are required for all Refuge uses, excluding management actions, per the 1997 National Wildlife Refuge System Improvement Act. They evaluate an activity's compatibility with refuge purposes and outline measures to ensure compatibility which must be followed if the use is to be allowed. This HMP tiers to the most current Refuge CDs on file, most of them dated 2004. No new CDs are expected to be written as a result of this HMP, because actions proposed will all be related to habitat management. However, CDs will be revised during the CCP process.

Regional and National Plans

The Refuge will continue to work in concert with several State and regional partners in the conservation of our trust resources through the participatory implementation of the following plans and programs.

USFWS Migratory Bird Program Strategic Plan
This 10-year (2004-2014) strategic plan outlines goals and strategies to sustain and restore bird migrations and natural systems (USFWS 2004). Key themes for this plan are: monitoring and management actions for migratory birds based on sound science; obtaining information on how priority birds respond to human-caused threats and habitat restoration; doing good things for migratory birds and habitats through partnerships.

Chincoteague NWR can contribute to the goals and strategies of Migratory Bird Program Strategic Plan by: 1) Supporting research studies on the Refuge by partners, 2) Conducting biological monitoring that contributes to region-wide population or habitat assessments; and 3) Managing Refuge habitats and conducting activities to protect and enhance migratory birds.

North American Waterfowl Management Plan (NAWMP)
Initiated in 1986, the NAWMP specifies population goals and habitat conservation strategies needed to restore and sustain waterfowl, focusing on a partnership approach in the United States, Canada, and Mexico. Its overall objective was to restore numbers of waterfowl to 1970s population levels. The 1998 NAWMP Update acknowledged that population goals had, with some exceptions, been achieved. Updated objectives of the NAWMP include focusing efforts on declining species, implementing landscape actions needed to sustain waterfowl populations, linking to other bird and habitat conservation plans, and broadening the scope of partnerships. According to the 2004 NAWMP Strategic Guidance, the following species have experienced declining trends for the past 30 or more years: American black duck, scaup (two species), scoters (three species), and long-tailed duck. Furthermore, populations of Atlantic Flyway resident Canada geese need to be reduced by 50% (USFWS et al. 2004).

CNWR contributions to the NAWMP can best be achieved through participation in the Atlantic Coast Joint Venture. The Eastern Shore of Virginia-Seaside is a focus area in the Atlantic Coast Joint Venture (www.acjv.org/maps/va_waterfowl_web_map.pdf)

Atlantic Coast Joint Venture Management Plan (ACJVMP)
The most recent version found was the 2005 Draft available on the web (_____2009). Species identified as High or Moderately High priority for which CNWR has the ability to implement conservation or management actions are: American black duck, mallard, canvasback, bufflehead, long-tailed duck, scaup, and scoters (black, surf scoter, white-winged). An effort will be made to address the following ACJVMP habitat enhancement and management strategies in the development of this HMP: 1) Improve water level management on managed wetlands; 2) Control exotic and invasive species; 3) Enhance habitats on Federal lands; 4) Conduct prescribed burning; and 5) Restore tidal wetland hydrology.

North American Bird Conservation Initiative (NABCI)
The Initiative brings together landbird (i.e., Partners in Flight), shorebird (i.e., North American Shorebird Conservation Plan), waterbird (i.e., North American Waterbird Conservation Plan), and waterfowl management planning efforts from the last two decades into a coordinated effort to protect and restore all native bird populations and their habitats in North America. The NABCI integrates bird conservation partnerships and reduces redundancy in the structure, planning and implementation of conservation projects. CNWR is located within the New England/Mid-Atlantic Region (BCR 30). The Implementation Plan for BCR 30 was completed in June 2008. (Steinkamp 2008).

The BCR 30 Implementation Plan identifies 134 priority species, 79 of which are categorized as "highest" or "high" priority for conservation. Most of these species are associated with coastal and forested ecosystems. The BCR 30 Plan outlines landscape scale, science-based, conservation actions to conserve birds and habitats. We considered BCR 30 priority species/habitats, and the most recently published list of Bird Species of Conservation Concern for BCR 30 (USFWS 2008a), in developing focal species and objectives for this HMP.

North American Monarch Conservation Plan
This international plan encompassing Canada, United States and Mexico outlines threats and conservation actions for monarch breeding, flyway, and wintering areas (Commission for Environmental Cooperation 2008). A 12-year study by Denise Gibbs documented CNWR's importance as a monarch flyway (Gibbs 2008). Both of these documents were important in formulating objectives and strategies to protect migrating monarch butterflies on the Refuge.

Recovery Plans
Chincoteague NWR is covered by four Federal Endangered Species Act Recovery Plans: Atlantic Coast Piping Plover (*Chadradius melodus*) Recovery Plan (USFWS 1995), Delmarva Peninsula Fox Squirrel (*Sciurus niger cinereus*) Recovery Plan (USFWS 1993), Recovery Plan for Seabeach Amaranth (*Amaranthus pumilus*) Rafinesque (USFWS 1996), and Recovery Plan for U.S. Populations of Loggerhead Turtle (*Caretta caretta*) (NMFS and USFWS 2008). Current refuge management with respect to these federally listed species has been guided by these Recovery Plans and numerous ESA Section 7/Biological Opinions for refuge projects. This HMP will incorporate and build upon these.

State Comprehensive Wildlife Conservation Plan and Biodiversity Initiative
In 2001, Congress established a new "State Wildlife Grants" program that provides funds to State wildlife agencies for the conservation of fish and wildlife and their habitats. Each state was charged with developing a Comprehensive Wildlife Conservation Strategy, also known as "State Wildlife Action Plans". Through this process the State identified which species and habitats are in greatest need of conservation. Virginia completed its plan in 2005 (VDGIF 2005). Eighty-eight wildlife species listed in this plan occur on Chincoteague and/or Wallops Is NWR (Appendix 1).

Virginia Coast Avian Partnership (VCAP)

Nearly all of Virginia's barrier islands and lagoon systems are under some sort of conservation protection by federal, state, and/or private agencies/organizations including USFWS, Virginia Department of Game and Inland Fisheries (VDGIF), Virginia Department of Conservation and Recreation (VDCR), and The Nature Conservancy (TNC). The latter manages 14 barrier islands as the Virginia Coast Reserve, including parts of Cedar and Metompkin Islands (The Nature Conservancy 1996). USFWS works closely with TNC and other land management agencies to implement cooperative monitoring and management actions on Virginia's coastal barrier islands. The goal of the partnership is to ensure the long-term viability of avian communities, species, and habitats in the Virginia barrier islands system through a partnership approach. A Conservation Action Plan (The Nature Conservancy 1996) outlines monitoring, research, and management actions for all of Virginia's barrier islands. The plan is currently being updated by TNC.

The Virginia Coast Reserve Long-Term Ecological Research (VCR LTER) project, funded by the National Science Foundation and administered by the Department of Environmental Sciences of the University of Virginia, conducts research on barrier islands and associated marshes and lagoon systems. The goal for the VCR LTER program is to develop a predictive understanding of the response of coastal barrier systems to long-term environmental changes in climate, sea level and land use, and to relate these to the ecological services the coastal barrier systems provide (VCR LTER_____). Although most of the research sites are located south of CNWR, results from these studies provide a sound and valuable scientific resource for all Virginia barrier island land managers. Published and unpublished reports were used in developing HMP goals, objectives, and strategies.

Chapter 2. Background

- Refuge Location
- Management Units
- Description of Habitats
- Ecological Processes & Anthropogenic Disturbances
- Physical Features
- Wildlife Resources: Current Condition

Figure 1a. Location Map & Management Units

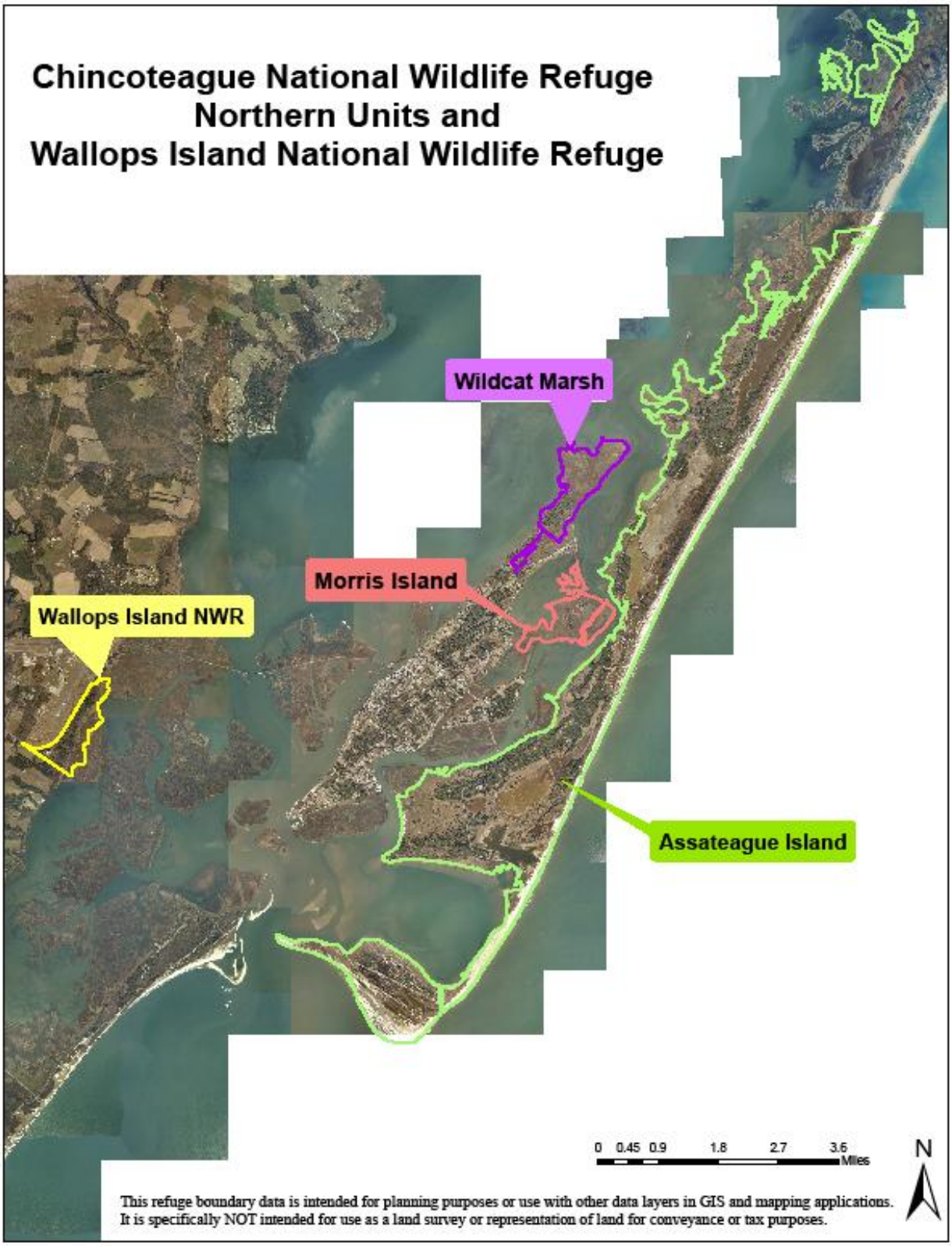
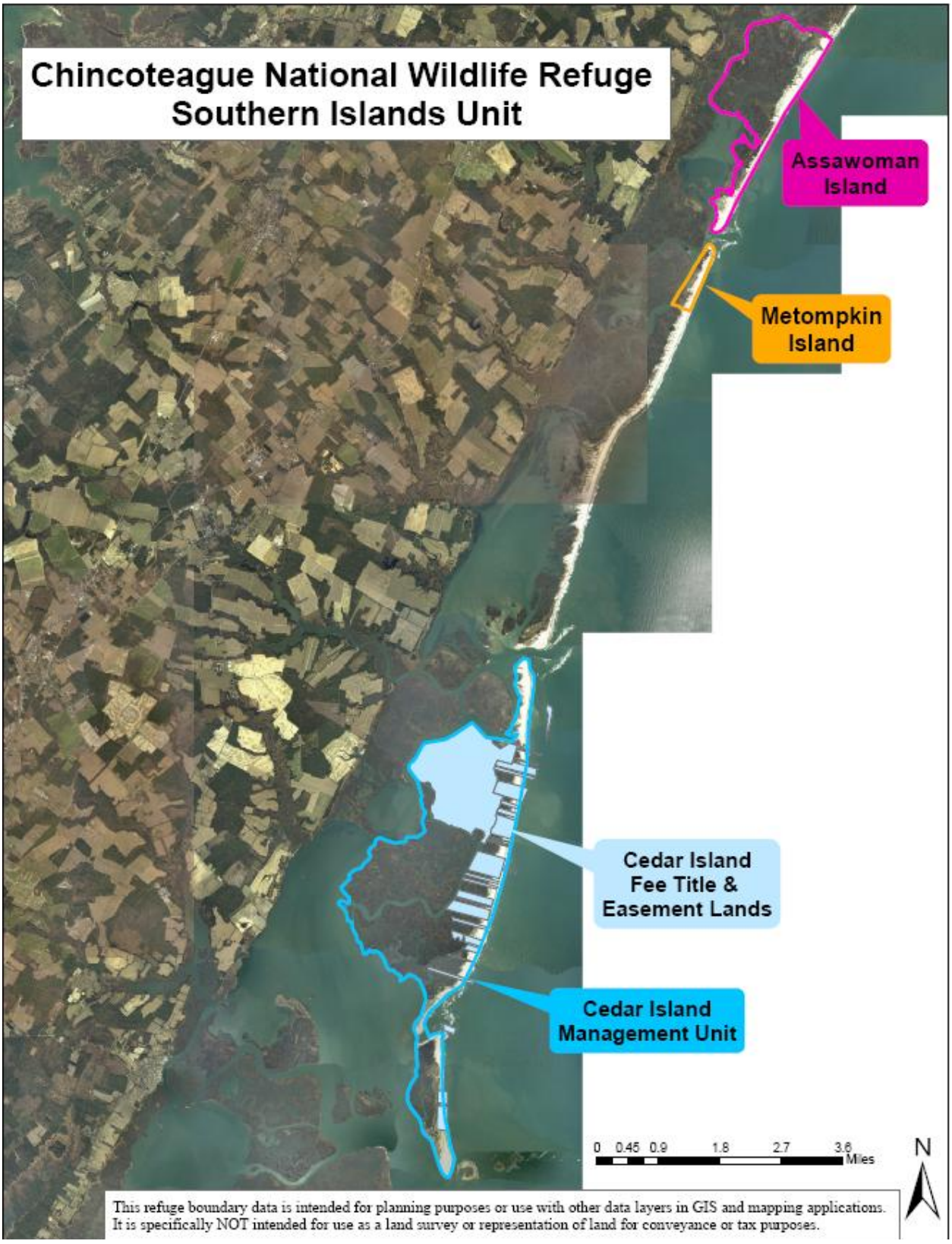


Figure 1b. Location & Management Units (South)



2.1 Refuge Location

The Chincoteague National Wildlife Refuge is located primarily in Accomack County, Virginia with approximately 418 acres in Worcester County, Maryland. Most of the 14,032-acre Refuge is located on the southern end of Assateague Island (9,021 acres), a 37-mile long, mid-Atlantic, coastal, barrier island on the east side of the Delmarva Peninsula. In addition, the Refuge operates three divisions that are located on islands which, including Assateague Island, extend over 30 miles along the Atlantic Coast. Assawoman Island Division contains 1,434 acres and encompasses the entire island; Metompkin Island Division consists of 174 acres on the north end of the island; and Cedar Island Division contains 1,412 acres in fee title and 600 acres in easements[1]. Additional lands can be found on the north end of Chincoteague Island, Wildcat Marsh (546 acres) and on Morris Island (427 acres), which is located between Chincoteague and Assateague Islands (Figure 1).

A bridge spanning Assateague Channel separates Refuge headquarters from the Town of Chincoteague. Chincoteague, the largest community in Accomack County (population 40,000), had approximately 4,300 permanent residents in 2009 (Chincoteague 2009). Numerous small rural communities and towns surround the Refuge. The Refuge headquarters and visitor center are located about a mile from the Chincoteague town center.

2.2 Management Units

Major habitat types serve as management units for Assateague Island and Wallops NWR (Figure 3). Other management units consist of individual islands that are part of CNWR (Table 2-1 and Figure 1). Thirteen impoundments will be managed as individual sub-units.

Table 2-1 Management Units

Location	Unit Name	Acres	Comments
Assateague Island	Beach/Dune	970	Acres estimated from 1994 Cover Map. Multiple vegetation types were grouped into 5 community types (Units) for management ease
"	Shrub/Early Successional	2,872	
"	Forested Uplands	1,600	
"	Impoundments	2,012	
"	Salt Marsh	1,985	
Chincoteague Island	Wildcat Marsh	546	87% salt marsh; 13% forested uplands
Morris Island	Morris Island	427	95% salt marsh; 5% forest/shrub
Assawoman Island	Assawoman	1,434	25% beach/dune ; 75% salt marsh
Metompkin Island	Metompkin	174	55% beach /dune;45% salt marsh
Cedar Island	Cedar	2,012	20% beach/dune;80% salt marsh
CNWR Total		**14,032**	
Wallops Island NWR	Salt marsh	195	Wallops Island acreages from WINWR 2007 Hunt Environmental Assessment
"	Forest	121	
"	Old Fields/Early Successional	57	
WINWR Total		**373**	

The acreage figures for Assateague Island Management Units and percentages of habitat types assigned to the southern barrier islands in Table 2-1 were generated from a 1994 land cover map, most recently validated in 1999 (Allen 1999), and various unpublished Refuge reports (Chincoteague NWR 2007(a) and (b) and Chincoteague NWR 1993. The areas assigned to each

[1] Cedar Island USFWS-owned parcels on Fig 1 appear to be in the ocean due to barrier island movement.

habitat type are approximate and give a rough idea of the proportion of each habitat type on the Refuges. A dynamic environment and shoreline constantly modified by storm and extreme high tide means that the amount of beach/dune and salt marsh habitat varies from year to year and season. Encroachment of shrubs and trees into impoundments, and an outdated cover map further contribute to the difficulty in accurately estimating Refuges' cover types.

All management units on Assateague Island are accessible by vehicle. A private community road ends at the boundary of Wildcat Marsh, and the upland portions are accessible by walking ancient sand dunes covered by pine trees. The remainder of Wildcat Marsh and all of Morris Island is accessible by boat. Assawoman Island was joined to Wallops Island (NASA), when natural processes silted in the Assawoman Inlet. Refuge and other authorized personnel can access Assawoman by driving 4-wheel drive vehicles on the beach south from Wallops, although NASA operations and security requirements sometimes restrict land access. Assawoman is also accessible by boat. Metompkin and Cedar Islands are only accessible by boat.

Wallops Island NWR is on the mainland immediately adjacent to Hwy 175. The nomenclature of the Refuge is somewhat confusing. The Refuge is not an island. However, a nearby island is named Wallops Island. Also, the land surrounding WINWR and Wallops Island proper are managed by NASA-Wallops Flight Facility.

2.3 Description of Habitats

Assateague Island

Beach/Dune

This habitat type covers approximately 970 acres, or 10%, of Assateague Unit. Its width varies along its 27 km (17 mile) interface with the ocean (Figure 3). Considered pioneer species, beach plants are exposed and adapted to constantly shifting sands, limited fresh water, temperature and wind extremes, and frequent salt water spray and overwash. The entire community can be covered by tidal surges. The beach extends from the intertidal zone into the dunes along the entire east and south sides of Assateague Island. Smaller areas are along Toms Cove and Assateague Point and Channel. The most common beach species are American sea rocket (*Cakile edentula*) and sea lavender (*Limonium carolinianum*).

A gradual transition from beach to the dunegrass community occurs beyond the high tide line. Dunegrass establishes readily on the stabilized dunes as well as in natural areas. Characteristic species are American beach grass (*Ammophila breviligulata)*, sea-oats (*Uniola paniculata*), saltmeadow cordgrass (*Spartina patens*), seaside goldenrod (*Solidago sempervirens*), dune sandbur (*Cenchrus tribuloides*), rough buttonweed (*Diodia radula)*, carpetweed (*Mollugo verticillata*), and seabeach evening primrose (*Oenothera humifusa*). Seabeach amaranth (*Amaranth pumilus*), a federally threatened plant, occurs in very low numbers.

Shrub/Early Successional

The majority of this habitat, covering 2,872 acres (roughly 25- 30%) of Assateague Unit, (Table 2.1 and Figure 3) extends north and south on barrier flats and backdunes, gradually merging on the east with dunegrasses of the beach/dune community, and on the west with marshes or forests. Small pockets of this habitat are scattered throughout Assateague Island. Shrubs, small trees, and vines are predominant plant forms.

Figure 2 Impoundments & Water Control Structures–Assateague Is (maps based on CNWR 1993)

Figure 2a Impoundments & Water Control Structures - South

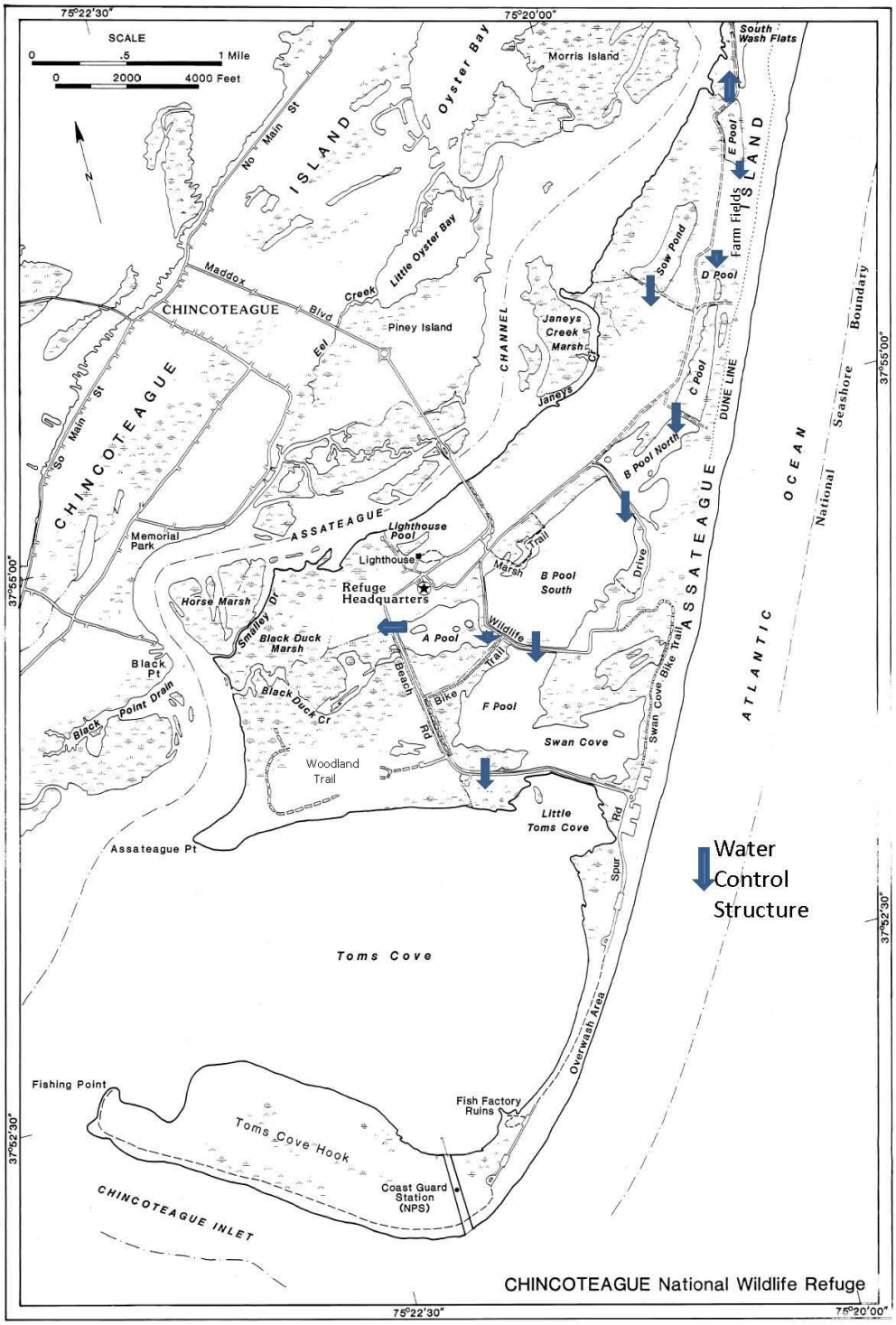


Figure 2b Impoundments & Water Control Structures - North

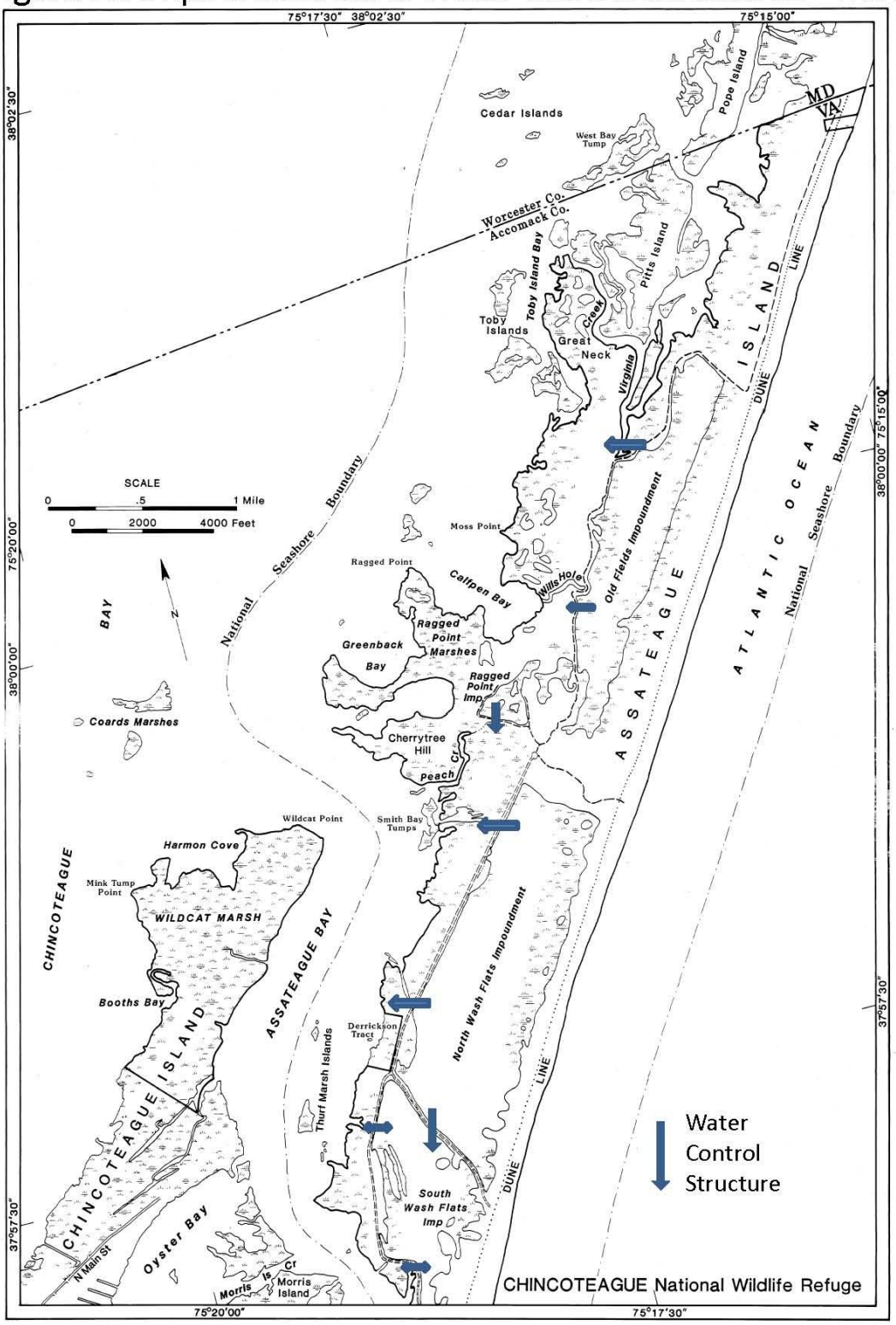
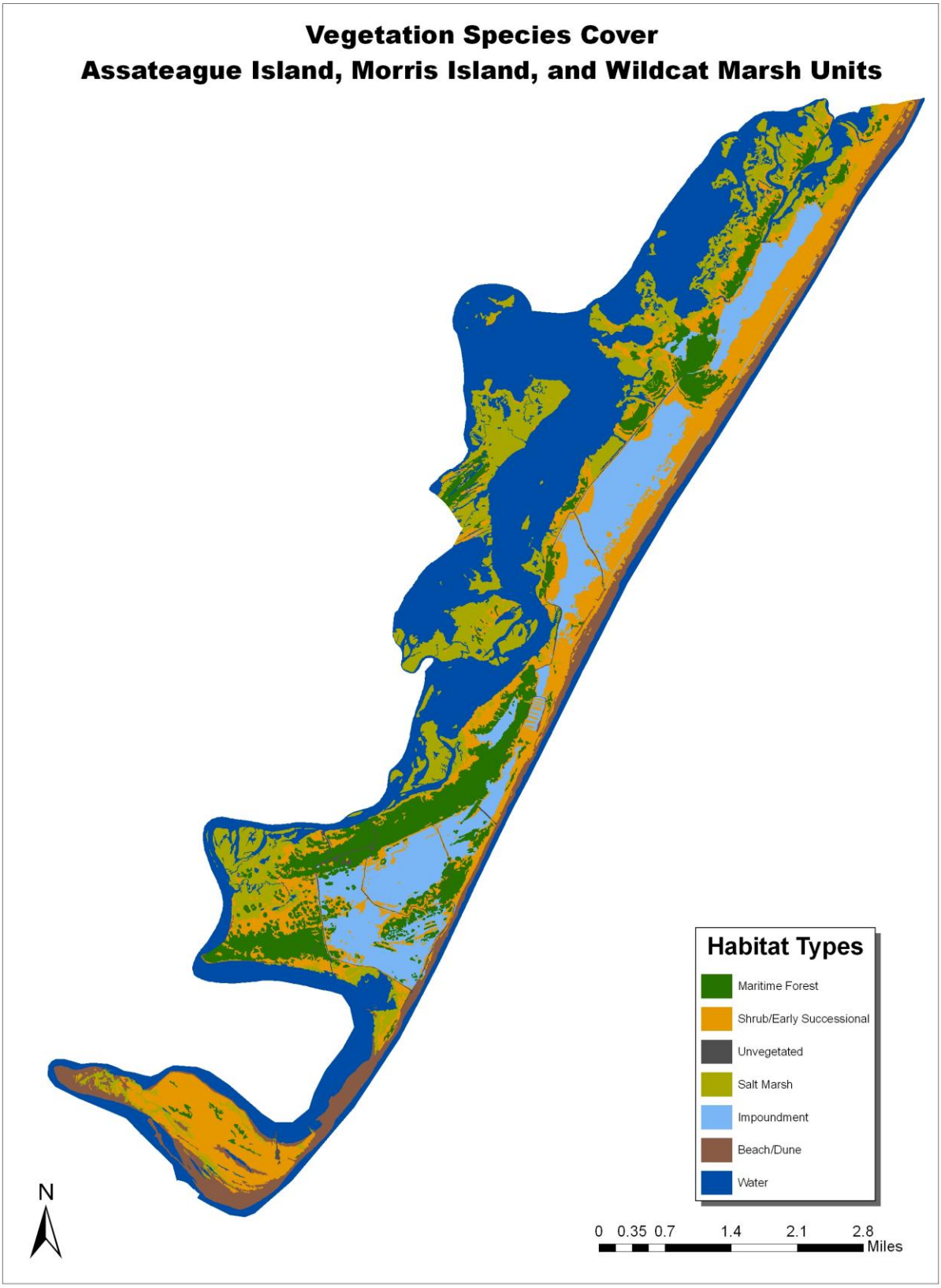


Figure 3 Vegetation and Habitat Types: Assateague Island, Morris & Wildcat Units



Common species include wax myrtle (*Morella cerifera*), northern bayberry (*M.pennsylvanica*), black cherry (*Prunus serotina*), Canada serviceberry (*Amelanchier canadensis*), blackberry (*Rubus allegheniensis*), poison ivy (*Toxicodendron radicans*), and greenbrier (*Smilax rotundifolia*). Evergreens are less frequent, but include red cedar, (*Juniperus virginiana*) and American holly (*Ilex opaca*). Most of these shrub species also occur to a lesser degree in the forest community. False heather (*Hudsonia tomentosa*), is the dominant species in localized areas within the shrub community. False heather forms large mound-shaped colonies on low interior dunes that are generally very dry and free of salt spray. This plant is an important dune stabilizer, capturing windblown sands.

Forested Uplands

The upland forest community occurs in several large stands on stable dunes, generally west of shrub areas and impoundments. They represent portions of Assateague Island that have been stable for the longest time, at least 100 years or more judging from the age of the trees.

Approximately 1,600 acres (17%) of Assateague Unit are classified as upland forest. Most stands are pure, or almost pure, loblolly pine. Mixed loblolly pine (*Pinus taeda*) and hardwood stands contain southern red oak (*Quercus falcata*), white oak (*Quercus alba*), and water oak (*Quercus nigra*) as the most abundant hardwoods. Other hardwood species found include red maple (*Acer rubrum*), sweet gum (*Liquidamber styraciflua*), sassafras (*Sassafras albidum*), black gum (*Nyssa sylvatica*), black cherry, American holly, wax myrtle, and black willow (*Salix nigra)*.

Forested understory vegetation is usually composed of dogwood (*Cornus florida*), high-bush blueberry (*Vaccinium corymbosum*), blackberry, greenbrier (*Smilax rotundifolia*), poison ivy, common chokecherry (*Prunus virginiana*), and fox grape (*Vitis labrusca*). The forest habitat is where many of the locally rare or uncommon plants on Assateague Island are found, including Indian pipe (*Monotropa uniflora*), crested yellow orchid (*Platanthera cristata*), pink lady slipper (*Cyprepedium* acaule), spotted wintergreen (*Pyrol*a *americana*), and partridgeberry (*Mitchella repens*).

Approximately 400 acres of the forested uplands on Assateague Island in Virginia were mapped as maritime upland forest community as defined by VDCR and 50CFR 84.11 (Berman and Berquist 2007). Maritime upland forests contain species-poor evergreen and mixed coastal forests, often pine-dominated with an understory of deciduous trees; they grow in well to rapidly drained nutrient poor sandy soils (Berman and Berquist 2007). They occur on old coastal dunes that have been stable long enough to sustain forests, have well-drained sandy soils, and a water table close to the surface (50 CFR 84.11).

Impoundments and Freshwater Wetlands

Thirteen[2] impoundments (roughly 22-28% of Assateague) are managed to provide submergent and emergent wetland vegetation and mudflats as foraging areas and cover for waterfowl, shorebirds, and other waterbirds Approximately 2,650 acres of this "habitat type" is contained within the dikes. The discrepancy between this and the 2,012 acreage figure obtained from the cover map (Table 2-1) is due to shrub encroachment on the edges, which was mapped as shrub/early successional. Since many impoundments tend to be brackish due to storm overwash and salty soils, they are inhabited by plants with some salt tolerance. Characteristic plants include dwarf spike rush (*Eleocharis parvula*), salt marsh fleabane (*Pluchea odorata*), Bacopa (*Bacopa monnieri*), Sago pondweed (*Potamogeton pectinatus*), American three-square (*Scirpus americanus*), saltgrass (*Distichlis spicata*), large bur-marigold (*Bidens laevis.*), smartweed (*Polygonum* spp.), umbrella-grass (*Fuirena pumila*), and salt meadow grass. Non-native

[2] A 14th impoundment, Lighthouse Meadow (7 acres), was abandoned sometime prior to 2005.

Phragmites australis grows in many of the impoundments and other wetland areas. This invasive plant has been the target of mechanical and chemical control efforts, summarized in Section 2.4.

Wax myrtle and loblolly pine encroach into some of the impoundments where these woody species are not regularly controlled. Currently, Sow Pond, Ragged Point, D-Pool, South Wash Flats, and North Wash Flats have expanding areas of woody vegetation that will require management to maintain open shallow water habitat favored by shorebirds and some waterfowl. On the other hand, flooded myrtle habitat is used by wintering black ducks, and landbirds use shrub habitat on impoundment edges for breeding, winter, and migration habitat. This HMP will develop objectives and management prescriptions to meet the multiple needs of focal species that depend on impoundments.

Forested wetlands occur on the west side of B Pool, in the vicinity of the Woodland Trail, and in lowlands near the White Hills. Dominant species include red maple, black willow, wax myrtle, ferns, and blueberries.

A more open transitional freshwater marsh that borders uplands and salt marshes on the bayside of Assateague Island includes groundsel tree (*Baccharis halimifolia*), cattails (*Typha angustifolia* L.), wax myrtle, swamp rose (*Hibiscus palustris*) and marsh elder (*Iva frutescens*). Approximately 108 acres of wetlands also occur on Toms Cove Hook on the flats and in low areas between the beach ridges and dunes that pond collect rainwater. A few other small natural freshwater marshes occur behind the dunes of the northern beach.

Salt Marsh

Approximately 2,875 acres of salt marshes are located along the western boundaries of Assateague Unit, on the north end of Chincoteague Island (Wildcat Mash Unit), and the majority of Morris Island Unit. Tidal flooding influences the distribution of salt marsh plants. Salt marsh cordgrass (*Spartina alternaflora*) is the dominant species in the low marsh, the zone between mean high tide and mean low tide. Salt meadow cordgrass (also called salt meadow hay), saltgrass (*Distichlis spicata*) and saltwort (*Salicornia europaea*) grow in the less frequently flooded high marsh. Northern sea lavender and marsh elder occur at upper levels, along the marsh/upland edge.

Salt marsh habitat covers approximately 95 percent (406 acres) of the Morris Island Unit and approximately 87 percent (485 acres) of the Wildcat Marsh Unit (Figure 3). Salt marsh cord grass, salt meadow cordgrass and saltwort are the major vegetation species. Upland vegetation on Morris Island is limited to a few scattered sites (21 acres) of loblolly pine, wax myrtle, black cherry and sassafras. Approximately 13 percent (73 acres) of the southern part of Wildcat Marsh is a upland forest consisting of loblolly pine, oak and typical understory associates. Wax myrtle is scattered throughout the area.

Rare Plants and Significant Ecological Communities

Seabeach amaranth (*Amaranthus pumilus*), a federally threatened plant, was first documented on the Refuge in 1966 by Dr. Elizabeth Higgins. It is an annual vascular plant endemic to Atlantic barrier island beaches from Massachusetts to South Carolina. The species typically inhabits upper beaches and overwash areas of active beaches. Seabeach amaranth was not recorded on the Refuge between 1972 and 2001 (Table 2.2), nor were any surveys documented. In 2001, nine plants were found just south of the MD/VA border, a year after the NPS began a program to restore the species in Maryland. Since 2001 Refuge staff has conducted surveys for seabeach amaranth on the beaches of Assateague Island each August, often in conjunction with NPS personnel.

Table 2-2 Seabeach Amaranth Occurrence on Assateague Island and Assawoman Island, VA

	1966	1967	1972	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Wild Beach	X	X	X	9	56	22	1	69	13	3	7	5	0
Hook	0	0	0	0	0	0	1	0	0	0	0	0	0
Assa-woman	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	0	0

(X =present; numbers not available; N/S= Not Surveyed) See Figure 6 for site locations.

Approximately 400 acres of Maritime Mixed Deciduous Forest, a globally significant community type (Fleming and Patterson 2010), is found on Lighthouse Ridge and White Hills on Assateague Island. Its "G1" rating indicates it is considered critically imperiled globally, with generally five or fewer occurrences and/or very few remaining acres or very vulnerable to elimination (Fleming and Patterson 2010). It occurs on high ridges of former dunes in the most sheltered sites where the barrier island is protected from extreme stresses of the maritime environment, such as storm waves and intense salt spray (Natureserve___). The canopy is composed of mixed loblolly pine, southern red and water oak; sub-canopy and understory include dogwood, sweet gum, American holly, high bush blueberry, sassafras, common chokecherry, and greenbrier (Natureserve___).

Southern Island Units

The Assawoman and Metompkin Island Units are barrier islands with habitat types consisting of beach, dunes, and extensive salt marshes to the west of the islands. The predominant species in the marsh include salt marsh cordgrass and salt meadow hay. On Metompkin the marsh extends to the mainland, although it is intersected by numerous creeks and channels. The remainder of the island is predominantly sparse grasslands with little woody growth. Assawoman Island also contains extensive salt marshes, particularly in the northern half of the island. A cobble-laden washover area, located at the northern tip and formed by the sealing of Assawoman Inlet, provides good habitat for nesting birds. Pockets of woody shrubs occur in depressions between the beach front and the westward marshes. Plants found here include wax myrtle, bayberry and groundsel bush.

Cedar Island is dominated by beach and dune habitats on the ocean side and a brackish marsh dominated by salt meadow cordgrass (hay) on the bay side. A small thicket dominated by eastern red cedar and poison ivy occurs on the north end of the island. It is adjacent to the beach and is eroding rapidly. The north end also supports most of the island's other plant diversity. Dead shrubs and some low-growing vegetation are present in overwash areas. Other habitat types found on Cedar Island include a salt flat to the south and mudflats that are exposed at low tide.

Wallops Island NWR

WINWR is composed of 195 acres of salt marsh, 121 acres of forest, and 57 acres of old-field/early successional forests. Loblolly pine is the dominant species in the forest habitat, secondary components include: tulip poplar (*Liriodendron tulipifera*), red maple, southern red oak, wild cherry, dogwood sassafras, and sweet gum. Understory includes: American holly, spicebush (*Lindera benzoin*), Devil's walking stick (*Aralias spinosa*), and greenbrier. Transition zones between the marsh and woodland are dominated by groundsel tree and wax myrtle. The salt marsh is dominated by cordgrasses (*Spartina alterniflora* and *S. patens*)

A Simoneaston Bay sea-level fen, named the Lucky Boy Fen, is found on WINWR (Appendix 9). Sea level fens are nutrient-poor, maritime seepage wetlands, confined to a few sites with an unusual combination of environmental conditions for the mid-Atlantic (VDCR 2001). The sea-level fen is a globally significant (G1) community type (Fleming and Patterson 2010); only four occur in Virginia, all of them in Accomack County (VDCR 2001). Lucky Boy fen is located just above highest tide levels, at the base of a slope where abundant groundwater discharges. It is less than one-half acre in size, but supports six rare plant species (Appendix 1).

2.4 Ecological Processes and Anthropogenic Disturbances

Barrier Island Dynamics

Wind, waves, and storm surges are constantly shaping and re-shaping the Refuge's barrier islands in a natural dynamic process. Strong waves and storm surges can erode entire beaches back to the dune line, or break through this protective barrier and overwash sand and salt water onto back dunes, flats, or wetlands. Natural dune location is determined by the frequency and extent of storms, and the rate at which prevailing winds and vegetation can rebuild dunes. The coastal edge of barrier islands progressively moves westward in a process called shoreline retreat. Sand is rolled across the dunes and marshes, and deposited into bays on the backside of the islands, such as Toms Cove on Assateague. This process, sometimes described as the "barrier island rolling over onto itself," will be accelerated with predicted climate change and sea level rise. For every one-foot rise in sea level, barrier islands move 100 to 1,000 feet inland (USFWS 1988).

Assateague Island is more than 37 miles long. The southern 17 miles are managed as Chincoteague NWR. Early 18th century maps show a smaller Assateague Island. It has developed southward as a series of re-curved spits deposited by currents that erode sands from northern beaches. Toms Cove Hook is a sand spit that has accreted since the 1850s (CNWR 2008). Assateague Island National Seashore staff continues to track this southward growth by mapping the entire shoreline twice a year.

Based on early 1950s photos in Refuge Annual Narratives, and accounts from a flight over the island in 1941 (NPS 2003), Assateague was historically a low, overwashed island with some low natural dunes. Conditions are unfavorable for the natural development of a tall dune system because strong waves and storm surges erode beaches back to the dune line, and create breaks in the dune line (CNWR 1993). During the 1950s, Refuge maintenance staff constructed several miles of "beach dikes" by bulldozing sand and installing sand fences to create dunes in order to facilitate building the Wash Flats and Old Fields Impoundments. These beach dikes were periodically blown out or washed out by storms, and repairs were frequent during the 1950s (Refuge Annual Narratives).

After a March 1962 nor'easter took out most of Assateague Island's "beach dikes", an artificial dune was created along the entire ocean-side of the island. It was constructed by bulldozing a dike of sand five feet high by 30 feet wide at base. A four foot high sand fence was placed on top of the dune to catch additional sand, and by 1963 wind-blown sand had been deposited against the fence to increase the height of the dune. In spots where insufficient sand was available to push up the dune, a larger dike was built that was approximately 6-7 feet high and 180-200 feet at the base with a 20:1 slope on the surf side; sand fence placed on top caught an additional four feet of drift sand (Refuge Annual Narrative 1962 and 1963).

From the 1960s into the 1990s, staff attempted to maintain the dune line in critical areas to protect impoundments and public use facilities from overwash and storm surges by repairing blowouts in the dunes, planting beach grass, and using fencing to encourage sand accumulation. For instance,

high seas from Hurricane Gloria, in the fall of 1985, overwashed several portions of the dune line near Old Fields Impoundment and east of B Pool. These low gaps were filled in with sand before winter storms could cause more extensive damage. In January 1992, a nor'easter destroyed much of the artificial dune line south of the parking lots; north of the beach parking lots portions of the artificial dunes were either overwashed or lost. Following the 1992 storm, about 2.5 miles of dunes between the north beach parking lot and D-Dike (Figure 6) were reconstructed and planted with beach grass (CNWR 1993 & Refuge Annual Narrative). After implementation of the 1993 Master Plan, maintaining the artificial dune line was de-emphasized, and occurred in selected areas to provide protection to facilities and wildlife habitat (CNWR 1993).

At present, Assateague Island's artificial dune system ranges from non-existent south of the beach parking lots, to well-developed with small gaps ocean-side of North Wash Flats and Old Fields Impoundments (Figure 6). Wash over occurs frequently in the Overwash Area, and in the parking lots. Overwash is common between autumn and spring, when nor'easters and prevailing winter winds scour the shoreline. Storm systems that occur during the highest lunar tides of the month can send sand filled waves over the beach, scouring everything in their paths, moving huge loads of sand from the ocean shoreline, depositing them in the cove side overwash fan. In summer, these events are less common. Prevailing winds blow sand from the overwash fan back to the beach, and littoral currents bring new sand from the north to further rebuild the beach face. Storm overwash has also occurred at numerous points along Wild Beach (Figure 6), sending sand and saltwater into the back dunes and barrier flats. These overwash events create ideal nesting substrate for piping plovers and terns; plover broods also forage in ponds that form in natural depressions behind the dunes.

In the face of accelerating sea level rise, Refuge management is re-evaluating its strategy of protecting the island's artificial dune system. Costly to maintain, the artificial dunes impede the natural migration of islands, sand transport, and overwash habitat creation, which is important for nesting shorebirds. The narrowing of Wild Beach and resulting scarcity of nesting habitat may be partly attributed to the artificial dunes. During the HMP/ CCP process, and Structured Decision Making exercise described in Chapter 3, we will examine the trade-offs between protecting impoundments and visitor use facilities versus allowing natural barrier island processes to become more dominant.

By definition, barrier islands protect other features, such as lagoons and salt marshes, from direct ocean wave attack. Outer barrier islands like Assateague may provide some protection for inner islands such as Chincoteague Island. Therefore, Refuge habitat management actions may be of interest or concern to the townspeople of Chincoteague if they perceive them as affecting the barrier island dynamics.

Although longshore sediment movement and deposition is generally north to south on Virginia barrier islands, the area between Wallops and Smith Islands is not receiving a large sand supply (USFWS 1988). This, combined with sea level rise, is causing erosion and shoreline retreat of Assawoman, Metompkin and Cedar Islands' shorelines. Between 1911 and 1994 Assawoman Island's shoreline retreated at a rate of 4.9 to 5.2 meters (17 feet) per year (Morang et al. 2006). USFWS (1988) reported that Metompkin and Cedar shorelines are also retreating at approximately 17 feet per year.

Impoundments

Between 1952 and 1992, 14 impoundments totaling 2,623 acres were created from back dunes, overwash, farm fields, and salt marsh habitats. Management priorities and techniques have evolved over the years, and a brief history is important to plan future management strategies.

In the 1950s, "beach dikes" constructed along the shoreline (see previous section) not only served to impound rainfall – the source of all water for Refuge ponds – but also stabilized the dunes and prevented overwash. Dikes along the west sides of the impoundments became the transportation network for Refuge Service vehicles (i.e., Service Road that runs the length of all the impoundments) and public use activities. The Wildlife Loop, Black Duck Marsh, and Swan's Cove Bike/Hiking Trails are situated on impoundment dikes.

During the 1960s, management priorities evolved to incorporate impoundment management and active farming programs for waterfowl. The 1962 Ash Wednesday Nor'easter that flooded most of the town of Chincoteague overwashed Assateague Island and destroyed island stabilization efforts of the previous decade. Impoundment dikes and roads were repaired, artificial "beach dikes" were re-built higher, and miles of sand fence and thousands of seedlings were placed on the created dune system in efforts to stabilize the island shoreline. Intensive habitat manipulation projects including planting crops, mowing, and pumping water continued, and providing habitat for waterfowl nesting remained an emphasis.

During the 1970s, little habitat manipulation took place other than water level management. The decade of the 1980s brought a return of traditional wildlife management techniques including farming, burning, and invasive species control; duck production was emphasized at CNWR as it was throughout the NWRS.

During the 1990s and early 2000s, management emphasis was shifted toward beach-nesting species and forest habitat management. Water level and vegetation management continued (primarily disking and mowing in impoundments and chemical control of *Phragmites)* but in relatively smaller proportion to other wildlife and habitat management activities. Waterfowl breeding habitat was no longer a priority and shorebird management was re-emphasized. Control of non-native mute swans and resident Canada geese was implemented.

Precipitation is the only source of water for impoundments, so maintaining target water levels is challenging. Water control structures (WCS) are used to manipulate impoundment water levels according to desired objectives. WCS release water either into adjacent pools or through bayside channels into the tidal marshes. Water can be moved from pond to pond beginning at E-Pool and progressing southward through Farm Fields, D, C, B-North, B-South and F-Pool. The following impoundments are connected by WCS directly to the Bay: South Wash Flats, North Wash Flats, Old Fields, Sow Pond, Ragged Point, A-Pool, E-Pool and F-Pool. Occasionally estuarine water has entered impoundments bordering tidal creeks either intentionally (i.e. WCS opened to raise water levels during drought) or unintentionally (e.g. high tides, tidal surges and wave action during severe weather).

Invasive Species

Non-native plants are one of the most problematic anthropogenic disturbances that threaten habitats on the Refuges. Early detection and immediate response is the most effective method of preventing invasive plants from becoming established. Asiatic sand sedge (*Carex kobumgi*), has been treated with herbicide when it is found growing on dune areas of Assateague and Assawoman Islands. Autumn olive *(Elaeagnus umbellate*), originally planted along fence line to enhance wildlife habitat on WINWR, has formed dense thickets that lessens the habitat value of native uplands. Beach vitex (*Vitex rotundifolia)*, an Asian plant that impacts nesting habitat for birds and turtles, has not yet been found on Refuge beaches. Early detection and removal will be an important strategy to prevent establishment of this invasive, as one plant was found on the Maryland side of Assateague (Amanda Daisey, CNWR Biologist, pers. comm.).

Phragmites australis is a non-native plant that out-competes native wetland plants and overtakes important wildlife habitat. It provides little or no food or shelter for most wetland-dependent wildlife. *Phragmites* can also eliminate small intertidal channels and obliterate pond habitat in impoundments that provide foraging areas for waterfowl, shorebirds, invertebrates, and fish. The Mid-Atlantic Coast BCR identifies *Phragmites* as one of the greatest threats to the region's birds. Since 2004, *Phragmites* has been treated using a variety of methods and an adaptive management approach on Assateague, Assawoman, Metompkin, and Cedar Islands. An important aspect of the work has been partnering with other agencies and organizations including Virginia DCR, The Nature Conservancy, NPS-AINS, and Eastern Shore NWR to map, monitor, and treat this invasive plant. Methods have been refined, and progress has been made in areas where multiple years of treatment have occurred. However, vigilance in treatment of re-sprouts, outliers, and previously untreated patches of *Phragmites* is essential in controlling this tough, invasive plant. USFWS established a Structured Decision Making work group on *Phragmites* in 2010.

Ponies

One hundred and fifty adult ponies and their offspring of the year are allowed to graze within two fenced compartments, totaling approximately 4,000 acres, on the Assateague Island Unit. The Chincoteague Volunteer Fire Department (CVFD) owns the ponies and operates under a Special Use Permit. Although often referred to as "wild ponies", they are managed more like livestock. The CVFD rounds up all ponies three times a year for veterinary care and herd thinning, one of these being the annual pony penning, swim, and auction held in July. Most foals and some yearlings are sold at the auction to benefit the town's ambulance and fire protection services. The sale of offspring also serves to keep the population at the permitted 150 animals, since they are allowed to breed freely. The two pony compartments (North = 3,413 acres and South = 647 acres) are located away from sensitive wildlife habitat, including all beach/dune habitats and most of the impoundments. However, is not uncommon for ponies to escape their fences, and graze for extended periods in other areas (Buffa, pers. obs.).

2.5 Physical Features

Climate

The climatic conditions of the Refuge are moderated by the Atlantic Ocean. Summer days are typically hot and humid. Prevailing winds are from the northeast and southeast. Although autumn days are typically cool and clear, the season also marks the onset of nor'easters. These low pressure systems move up the coast, generating storms caused by counterclockwise cycling of moist air. Nor'easters are characterized by heavy rain, exceptionally strong northeast winds, high tides, and rough seas. Conditions may last for two to five days. Nor'easters are most intense in winter, carrying the greatest potential for overwash of ocean side dunes on Assateague Island. Winter temperatures are mild, with January-February temperatures averaging 49^{o}F (CNWR weather station #449906 data). Although snow is not uncommon, it rarely accumulates.

Rainfall is rather uniformly distributed throughout the year averaging about 3.5 inches a month and totaling about 42 inches a year. Annual precipitation totals have ranged from 10 to 80 inches during the period 1996-2008 (CNWR weather station #449906 data).

Soils

The soils of CNWR barrier islands consist of sand, silty loams and shell fragments, with sands found primarily on upland areas, and silty loams found in tidal marshes and other wetlands. Sandy soils and soil salinity are major influences on management capability in upland and impoundment habitat types because they limit plant species that can grow, and affect water quality and the ability to manage water levels. The soils of Wallops Island NWR consist primarily of sand on uplands and silty loams on tidal marshes and other wetlands. The following

soil types predominate: Assateague Fine Sand found on dunes, with some areas supporting loblolly pine and shrubs; Fisherman Fine Sand found in depressions and back dunes; Camocca Fine Sand occurring in shallow depressions between coastal dunes and level barrier flats, with some areas supporting stands of pines and hardwoods or wax myrtle-dominated shrub community; and Chincoteague Silt Loam located in impoundments and salt marshes between the barrier islands and mainland (USFWS 1992).

Topography

The topography of CNWR's barrier islands rise from the sea to merge into flat and gently rolling low sand dunes interspersed with barrier flats. Barrier flats have negligible relief and generally result when washovers or inlets destroy the original beach/dune ridge morphology. Large areas of barrier flats on Assateague Island were graded and impounded in the 1950s and 60s to create freshwater and brackish impoundments for waterfowl and shorebird habitat. The backdunes and barrier flats around the impoundments support grasslands and shrub thickets. Forests have developed on the barrier flats in the lee of the most protected dune areas. Assateague Island topography and the forces that shape it were also discussed in Section 2.4 above.

Assawoman Island is a 2.5 mile (4.3 km) long island consisting of narrow and sandy beaches and shell-covered flats on the seaside, low mudflats in the center of the island, and tidal salt marsh on the mainland side. Metompkin Island is 6.6 miles long but only the northern tip (approximately 1 mile in length), consisting of sandy beach and shell-covered flats, is within the CNWR. The rest of Metompkin is managed by The Nature Conservancy (TNC). Cedar is 6.5 miles (10.5 km) in length, with low topographical features comprised of beaches, shell flats, and tidal marshes.

WINWR topography is composed of generally flat forested uplands on the northwestern portion, grading into tidal salt marsh on the southeastern side.

Hydrology

No natural freshwater streams or lakes exist on CNWR. Rainfall and tidal overwash are the only sources of surface water on all the barrier islands. The moist soil units, ponds and impoundments are slightly brackish to highly saline because of tidal overwash, salt spray, and the accumulation of salt residue as water evaporates. These same environmental factors also render the shallow groundwater lenses beneath the islands brackish. Evaporation and transpiration account for major surface water depletion during the summer months. Large bodies of water bordering the Refuge are the Atlantic Ocean, Chincoteague Bay, and other smaller bays inland of the southern islands. The drinking water supply for Chincoteague Island and the Refuge comes via pipeline from three deep wells and a shallow well field near the NASA base on the mainland.

At least two natural freshwater streams exist on Wallops Island NWR, contiguous with two tidal tributaries of Little Simoneaston Creek, which borders the Refuge. Rainfall and tidal flooding are other sources of surface water on the Refuge. A Simoneaston Bay sea-level fen – named Lucky Boy Fen - also found on WINWR (CNWR 2007b), was described above in Section 2.3.

2.6 Refuge Resources: Current Conditions

Waterfowl

Chincoteague and Wallops Island NWRs lie within the Atlantic Flyway. Dozens of waterfowl species stop to feed and rest on Assateague Island's impoundments during fall and spring migration. Refuge impoundments support wintering snow geese, Canada geese, black ducks, mallards, green-winged teal, northern pintail, northern shoveler, gadwall, American wigeon, bufflehead, red-breasted merganser, ruddy duck, and tundra swan. Assateague Channel provides

important winter feeding habitat for Atlantic brant, which occasionally use Refuge impoundments for resting.

Peak numbers of waterfowl using CNWR impoundments occurs in November or December (unpubl. Refuge waterfowl census data). Peak waterfowl counts for November over the past 20-years have ranged from 3,616 in November 2007 to 56,326 in November 2008 (20-year average of peak counts is 25,674). Peak waterfowl counts for December over the past 20-years have ranged from 3,904 in December 2008 to 51,349 in December 1997 (20-year average of peak counts is 20,974). No trend in overall waterfowl numbers is apparent. Peak numbers have been higher than the 20-year average in five years of the past ten years (1999-2009), and lower than the 20-year average in the other five years. The same pattern is true for the previous decade (1989-1999); five of the years between 1989 and 1999 had "peak waterfowl numbers" below the 20-year average and five of those years were below the 20-year average. (Appendix 5)

Impoundments are managed to provide invertebrate and plant food sources, loafing cover, and winter thermo-regulatory cover. Vegetation is kept at an early successional stage by a combination of mowing, disking, prescribed fire, and chemical treatments (for invasive plants such as *Phragmites*). Water levels are manipulated in spring to provide moist soil conditions conducive to production of preferred waterfowl food plants. Dewatering of impoundments occurs mid-March through mid-June depending on the desired plant response and rainfall. Earlier draw-downs favor sedges, smartweeds, and bulrushes, with later drawdowns favor grasses. Late summer re-flooding provides desirable feeding sites for early fall migrants, particularly shorebirds. However, this is only possible with adequate rainfall. Fall re-flooding produces feeding conditions conducive to later migrants and to wintering waterfowl. Maintaining certain impoundments with high water levels year round, and flooding very large impoundments during the fall migration, creates roosting and loafing sites. Thermo-regulatory areas for waterfowl are maintained by allowing woody plants to remain within certain impoundments, or by raising the water level to flood wooded areas.

American black duck management is a high priority throughout their range because of declining populations and hybridization with mallards. Black duck populations peak during fall migration when 1,100 – 1,400 are typically counted during November impoundment surveys. Wintering numbers remain at about 400-600, until trailing off through the month of April. Impoundments that consistently winter good numbers of black ducks (defined as at least 100 birds in January during five of last 20 years) are B-North, B-South, F-Pool, North Wash Flats, and Old Fields. Impoundments with intermittently good numbers (defined as at least 100 birds in January during three of the last 20 years) are A-Pool, C-Pool, Farm Fields, and Sow Pond. Wintering black ducks have dropped noticeably since 2002 in North Wash Flats, Sow Pond, and Old Fields. Chincoteague is not considered a significant waterfowl production refuge, and production data has not been collected since the early 1990s. During the 1980s, duck production was emphasized on this Refuge and many others throughout the System due to extended prairie drought and declining duck numbers. Management activities to enhance waterfowl nesting no longer occur. Usually, a few broods of gadwall, mallards, black ducks, and wood ducks are present each year. Introduced into the Atlantic Flyway in the early 1990s and considered a nuisance species, resident (i.e., non-migratory) Canada geese nest on Refuge impoundments (Atlantic Flyway Council 1999). Resident geese and non-native mute swans are selectively removed from CNWR because they damage habitat that migrant and wintering species depend on.

Shorebirds

Chincoteague NWR is one of the country's top five shorebird migration staging areas east of the Rocky Mountains (CNWR 1993). It is designated a site of international importance by the

Western Hemisphere Shorebird Reserve Network (WHSRN). Peak shorebird numbers during spring migration occur in May. The fall migration usually peaks in August, and spans the period of July to October.

Spring migration begins with the arrival of piping plovers in March, but there are few other signs of migration before mid-April. During early spring migration, defined as the period of April 7 – May 6, 1,000 to 4,000 shorebirds may be present on Assateague Island habitats. The great majority are dunlins (50%) and sanderlings (22%), but short-billed dowitchers, black-bellied plovers, willets, and whimbrel are also present (Wilds 2007and Refuge unpubl. data). During late spring migration, defined as the period of May 7 – June 6, between 6,000 and 26,000 (typically 12,000 – 13,000) birds are present on Assateague. The majority (46%) are semipalmated sandpipers, but good numbers of dowitchers, sanderlings, least sandpipers, dunlin and ruddy turnstones are also present (Wilds 2007 and Refuge unpubl. data).

Fall migration begins around July 1 with the arrival of short-billed dowitchers. Soon thereafter greater and lesser yellowlegs and least and semipalmated sandpipers arrive, the latter species making up the vast majority (around 40%) of shorebird numbers present July – September (Wilds 2007). Virtually all migrants present in July are adults. Hatching year migrants are not common until the last third of August, and by the last third of September, juveniles usually comprise the only shorebirds around, except for adults of shorebird species that overwinter.

Red knots (*Calidris canutus rufa*), a species considered for listing under the Endangered Species Act (ESA), uses Chincoteague NWR beaches during spring and fall migration, with peak spring numbers occurring in the last half of May and peak fall numbers occurring in August (Smith et al. 2008a and unpubl. Refuge data). Since the 1980s, the *rufa* population of red knots has declined 68-80%; the severe decrease in a major food item during migration - horseshoe crab eggs in Delaware Bay- a suspected cause (Cohen et al. 2009). A significant proportion (25-30%) of the *rufa* population (estimate 10,000-13,000) red knots use Virginia's barrier islands during spring migration (Cohen et al. 2009). While migrating through the eastern shore of Virginia, they feed primarily on clams, such as *Donax variabilis*, and crustaceans rather than horseshoe crab eggs (Cohen et al. 2009). These recent findings that Virginia barrier islands support a significant migratory red knot population add importance to CNWR's role in red knot conservation. Migrant shorebirds use Assateague beaches, tidal flats, and impoundments. B-North, B-South, F-Pool, A-Pool, Old Fields, South Wash Flats, and North Wash Flats are the most important for shorebirds (Wilds 2007 and Refuge unpubl. data). D and E Pools, Sow Pond, and Ragged Point, typically have little or no shorebird use. The Hook is the most important beach area on Assateague Island for migrant and nesting shorebirds (Refuge unpubl data).

Beaches on Assateague (including the Hook, Overwash, and Wild Beach), Assawoman, Metompkin, and Cedar Islands are managed and intensively monitored for nesting shorebirds including the federally threatened piping plover, American oystercatcher, and terns. The North Wash Flats impoundment is also intensely managed for piping plover nesting habitat. The number of piping plover nesting pairs on CNWR has increased from 50 pairs in 1987 to 100 or more pairs in recent years (2005-2010). The number of piping plover chicks fledged increased steadily between 1987 (when monitoring began) and 2004 (with a peak of 224 fledged chicks), declined from 2005 to 2008, and increased slightly (132 chicks fledged) in 2009 and 2010. Weather events and predation affect fledgling success. Productivity has reached or exceeded the Recovery Plan goal of 1.5 chicks/pair in five of the last ten years (USFWS 1995, and Table 4.1). Prior to 2007, Assateague Island consistently had the highest number of nesting plover pairs, but in recent years (2007-2009), Cedar and Assawoman have had more breeding pairs and higher fledgling success.

Increased flooding events due to high tides on the Hook and Overwash during the breeding season, and erosion of Wild Beach are factors.

Refuge staff has cooperated with the VDGIF and TNC to monitor American oystercatcher population size and breeding success since 2001. In 2008, the Refuge supported 25% (100) of the total number (395) of nesting pairs on Virginia's barrier islands. This amounts to 14% of the state's total number of breeding pairs (731). Cedar Island has the most breeding pairs on the Refuge, followed by Assawoman and Assateague. Metompkin Island had largest population (95 breeding pairs) of oystercatchers on any of Virginia's barrier islands, however only 14 pairs nested on the Refuge portion. Refuge staff also conducts boat-based breeding and fall/ winter roost surveys of oystercatchers in Chincoteague Bay, when staffing allows.

Gulls and Terns

Assateague, Assawoman, Metompkin, and Cedar Island beaches provide nesting habitat for ground nesting colonial species shown in Table 2.3. Least and common terns showed more year to year consistency in use of Refuge islands for nesting as compared to black skimmers and gull-billed terns (Table 2-3). Gull-billed terns, a species of concern in several ranking systems (Appendix 1), declined by 60% between 1977 and 2003 on Virginia's barrier islands (Molina and Erwin 2006). Flooding of nesting sites, human disturbance and predation are probable factors. Black skimmer is identified as a USFWS Bird of Conservation Concern and received priority in other ranking systems as well (Appendix 1). CNWR also provides feeding areas for Forster's terns and resting sites for migrating Caspian and royal terns.

Table 2-3 Gull/Tern Colony Locations 2005-2010

YEAR	ASSATEAGUE	ASSAWOMAN	METOMPKIN	CEDAR
2010	Least, Common Tern Black Skimmer	Least, Common, Gull-billed Tern, Skimmer	Common Tern Black Skimmer	Least, Common Tern, Black Skimmer
2009	Least, Common Tern	Least, Common Tern	Least, Common Tern Black Skimmer	Least, Common Tern Black Skimmer
2008	Least, Common Tern	Least, Common Tern	Least, Common Tern Black Skimmer	Least, Common Tern Black Skimmer
2007	Least , Common Tern	Least, Common Tern Black Skimmer	Least, Common Tern Gull-billed Tern Black Skimmer	Least Tern
2006	Least Tern	Least, Common Tern Gull-billed Tern Black Skimmer	Least, Common Tern	Black Skimmer
2005	Least Tern Black Skimmer	Least, Common Tern Black Skimmer	Least, Common Tern Black Skimmer	No Information

Secretive Marsh Birds

As their name implies, little is known about the status of rails, bitterns, night-herons, green heron, snipe, saltmarsh, and seaside sparrows on CNWR since they are rarely encountered during shorebird and waterfowl surveys. Clapper rail, sora, green heron, willet, marsh and sedge wrens, saltmarsh and seaside sparrows are all listed as nesting birds on the Refuge's bird list. No black rails were detected during a 2007 survey, using playback tapes, of potentially suitable habitat on or near the Refuge including Wildcat Marsh, Morris Island, Assateague Channel, Assawoman, and Metompkin Islands (Smith 2008b).

Wading Birds

The impoundments and their borrow ditches provide resting, feeding and brood-rearing habitat for wading birds such as tri-colored and little blue herons, great and snowy egrets and herons. Cattle egrets are commensal feeders with the Chincoteague ponies. Evaporation and drawdown of certain impoundments concentrate food resources for birds that breed on such marshy islands in Chincoteague Bay as Wire Narrows, Queens Sound, and Coards Marsh. These marshy islands support the largest nesting colony of waders in Virginia (Mike Erwin, USGS, pers. comm.). Large numbers of glossy ibis, egrets, and herons are often observed feeding in the drying pools and impoundment ditches in South Wash Flats, A-Pool, and F-Pool.

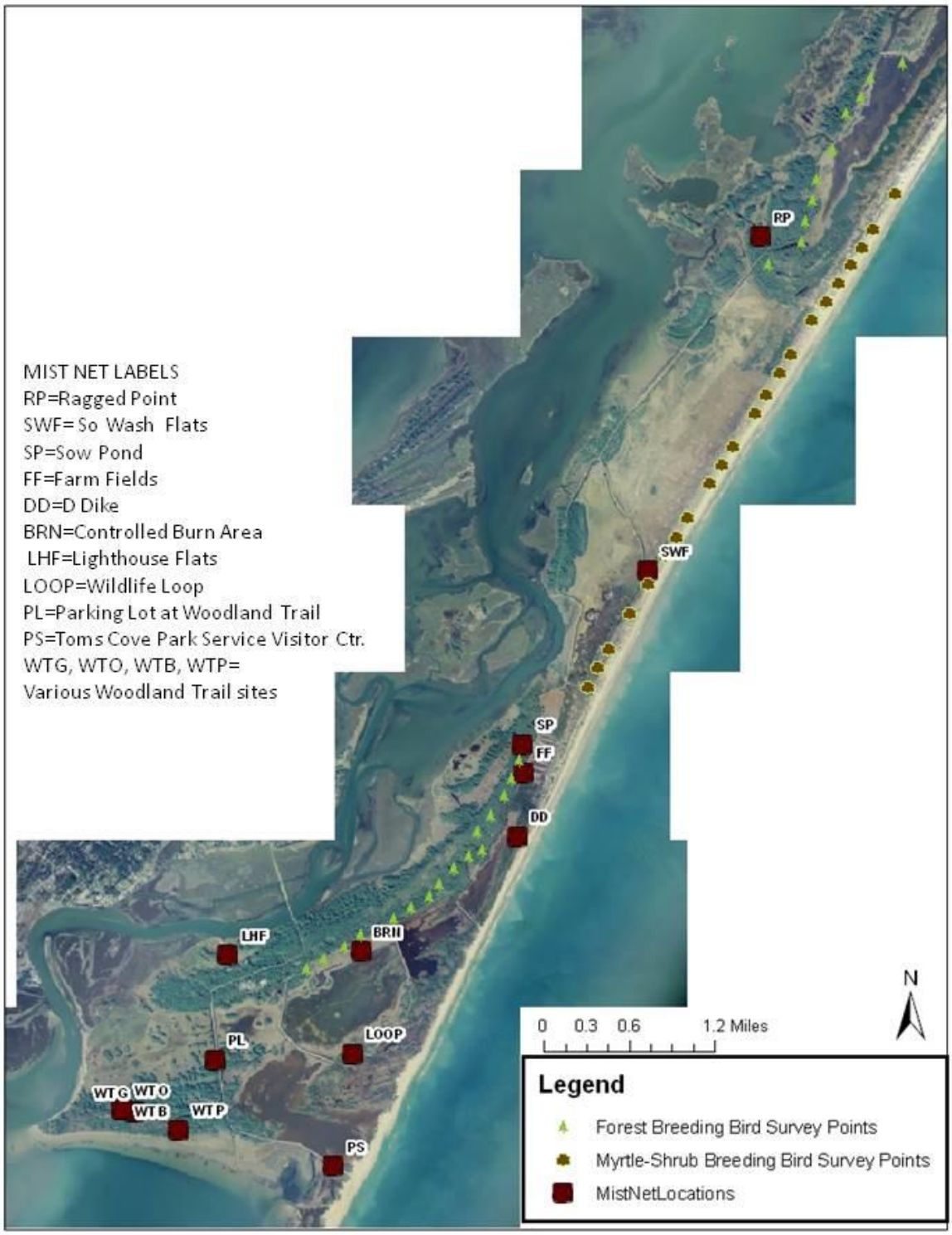
Raptors

Bald eagles were delisted from the federal Endangered Species Act (ESA) in 2007; however they are still a state-listed species in Virginia. The three known bald eagle nests on Chincoteague and Wallops Island NWRs are checked for activity in March and May each year by VDGIF. Nest AC-07-02 is located in a loblolly pine tree in A-Pool (Assateague Island); it is also monitored by a live video camera in the Herbert H. Bateman Educational and Administrative Center. Nest AC-03-03 is located in Wildcat Marsh, and Nest AC-08-02 is located on WINWR. In 2009, AC-07-02 produced two chicks; AC-03-03 was active but failed (Brian Watts, Ctr. Conser. Biol., pers. comm.). AC-08-02 was not occupied in 2009 and the nest has since blown over; the eagle pair did not re-nest on WINWR in 2010 (Brian Watts, Ctr. Conser. Biol., pers. comm.).

Assateague Island is a major resting and feeding area for peregrine falcons during fall migration. They hunt shorebirds and other prey items and use the beach as a resting area. In 1980 a peregrine hacking tower was erected on North Wash Flats (NWF), less than 1 mile south of the Maryland border. Eight falcon chicks were hacked from the tower in 1980 and 1981. The first successful nesting of peregrine falcons in Virginia after the DDT era occurred on the NWF tower in 1982, and pairs nesting on this tower produced a total of 54 fledglings between 1982 and 2003 (Watts et al. 2008). Between 2004 and 2008, pairs occupied the tower, but nesting was assumed to be unsuccessful based on behavior and aerial surveys. In 2008 the tower was climbed for the first time in several years, evidence of mammalian predation (probably raccoon) on the eggs was found, and the predator guards were in disrepair. The tower was removed prior to the 2009 breeding season because of conflicts with piping plover management objectives on North Wash Flats and a statewide decision to not repair or maintain existing peregrine towers located in important shorebird areas within the seaside lagoon system. The peregrine hacking tower on Metompkin Island was removed in 2010 for this reason.

Ospreys fish Refuge marshes and F-Pool, northern harriers hunt in marshes and impoundments, and red-tailed hawks nest in forests. Three species of owls are year-round residents. Eastern screech owls nest in Delmarva fox squirrel and wood duck nest boxes, as well as in natural cavities. Barn owls often nest in hunting blinds on adjacent marshes. Great horned owls prey on rabbits, Delmarva fox squirrels and shorebirds (USDA, pers. comm.). The Delmarva Peninsula funnels southbound migrating hawks, which stop to rest and feed on CNWR & WINWR during fall migration. Saw-whet owls use young regenerating pine stands on the backside of wildlife loop as winter roosting sites (Roberts, personal comm.).

Figure 4 Landbird Mist Net and BBS Survey Point Locations on Assateague Island



Landbirds

From 1999 - 2009, Refuge volunteer Dr. Richard (Dick) Roberts monitored landbird habitat use through mist netting and banding. During these ten years, Dr. Roberts sampled 14 different areas on CNWR, comprising shrub/early successional, forested uplands, and shrub/pine edge habitats (Figure 4). Some areas have been sampled for five consecutive years or more, others for three years or fewer (Roberts 2009). Nets are operated year-round, weather permitting. Overall goals of this monitoring are to:

1. Collect baseline data on species utilizing Refuge habitats as a basis for management decisions
2. Identify habitats being used by species of special concern
3. Document/confirm nesting and migrating species
4. Document the occurrence of rare or unusual species
5. Conduct environmental education

In shrub habitat dominated by wax myrtle/bayberry vegetation adjacent to the South Wash Flats impoundment, 72 species were captured during the 5-year sample period. Evidence of breeding common yellowthroats**, gray catbirds,** and **prairie warblers** was found. The latter is a highest priority USFWS Birds of Conservation Concern for the New England/Mid-Atlantic Coast Bird Conservation Region (BCR) 30 and gray catbird is a medium priority BCR 30 species (USFWS 2008a)[3]. Yellow-rumped (myrtle) warblers depend upon this habitat extensively during migration and winter. BCR Highest or High Priority Species (Appendix 1) that have been banded in this habitat during breeding or migration include (in order of relative abundance): **field sparrow, prairie warbler, brown thrasher, eastern towhee, great crested flycatcher, Baltimore oriole, eastern kingbird, worm-eating warbler,** and **northern flicker.** Medium priority BCR 30 species captured in this habitat in order of relative abundance are **gray catbird, Canada warbler,** and **blackburnian warbler.**

Dr. Roberts considers shrub habitats behind beach dunes, such as that typified by his study site adjacent to Toms Cove Visitor Center ("PS" on Figure 4), essential stopover habitat for southbound fall migrants. This habitat is particularly important to juvenile birds (and hence recruitment into the population), since 85-90% of birds migrating southbound through the mid-Atlantic coast are hatch-year birds (Roberts 2009). This vegetation on the lee side of the dunes appears to provide important refuge to birds inexperienced in navigation that may otherwise be blown out to sea without somewhere to shelter and re-fuel (Roberts 2009). BCR Highest or High Priority Species (Appendix 1) that have been captured in migration during 5 years of mist-netting in this site include (in order of relative abundance): **field sparrow, black-and-white warbler, eastern towhee, eastern kingbird, prairie warbler, Louisiana waterthrush, Baltimore oriole. Gray catbird**, a medium priority BCR 30 species, was captured in this study site, but at relatively low numbers compared to other sites.

Mist-netting/banding sites in forest habitat have been operated for one to three year periods in approximately six locations along the Woodland Trail and Wildlife Loop to measure response to habitat modifications such as pine bark beetle outbreaks and prescribed burns. The following BCR Highest or High Priority Species (Appendix 1) have been among the 75 species captured in this habitat (in order of relative abundance: **brown thrasher, field sparrow, northern flicker, eastern towhee, black-and-white warbler, Baltimore oriole, great-crested flycatcher, prairie warbler, eastern kingbird,** and **worm-eating warbler.** Medium priority BCR 30 species captured in this habitat in order of relative abundance are **gray catbird, brown-headed nuthatch,** and **red-headed woodpecker.**

[3] Birds of conservation concern on BCR 30 list appear in bold.

The longest consecutive mist netting/banding site operated by Dr. Roberts (2001-2009) is adjacent to the Woodland Trail parking lot. It is located on the edge between forested uplands and salt marsh habitat and contains more understory shrubs (myrtle, bayberry, greenbrier, and other berry-producing shrubs) than typical mature loblolly pine forest on Assateague Island. Bird species diversity was high: 87 species captured in a 9-year period. **Gray catbird**, a medium priority BCR 30 species, has the highest number of captures here compared to any other site. The following BCR Highest or High Priority Species (Appendix 1) have been captured at this site (in order of relative abundance): **black and white warbler, eastern towhee, Baltimore oriole, prairie warbler, eastern kingbird, northern flicker, field sparrow,** and **worm-eating warbler.**

The mist-netting study has provided valuable data, particularly for skulking species, non-singing migrants and wintering birds. However, canopy birds and larger species such as crows and bobwhite are under-represented. A breeding bird survey (BBS), conducted for ten years between 1996 and 2006, provides additional data on the Refuge's landbird population. Two BBS survey routes of 30 points each (Figure 4), spaced .5 miles apart, in myrtle shrub and loblolly pine forest (total = 60 points) were run during the second week of June using slightly modified BBS protocols (CNWR 1996).

Appendix 2 lists the 20 most abundant birds (in order of relative abundance) observed in each of the two habitats (myrtle shrub and loblolly pine forest) during the 10-year BBS survey period. Ten BCR 30 Priority Species breed on the Refuge: g**ray catbird, northern bobwhite**, and **brown thrasher** -found in both habitats; **field sparrow, eastern kingbird,** and **prairie warbler** - found in myrtle shrub; and **eastern towhee, great-crested flycatcher, northern flicke**r, and **brown-headed nuthatch** – found in loblolly pine forest.

Appendix 2 also compares the BBS results with Robert's twenty most abundant mist-net captures (1999-2007). Only nine species were on the top twenty in both the BBS survey and the mist net study: **gray catbird**, common yellowthroat, song sparrow, house wren, northern cardinal, common grackle, Carolina wren, **field sparrow**, and yellow-breasted chat. Birds that appear on Robert's "Top 20" and not on the BBS are generally wintering or migrant birds. For example, the most numerous wintering and migrant bird on the Refuge – yellow-rumped warbler – was not encountered at all on the BBS. Birds that appear on the BBS "Top 20" and not on Robert's study are canopy birds such as **eastern wood peewee, brown-headed nuthatch**, and **great-crested flycatcher**, or species too large to be captured in passerine mist nets such as crows and **bobwhite.**

Upland Game Birds

Based on the 10-year BBS noted above, northern bobwhite quail are widespread with a stable to increasing population trend on the Refuge. They were detected on 29 of 30 possible points in myrtle shrub vegetation over the 10-year period, and on average detected on 40% of the points each year. Quail were detected on all 30 points in loblolly pine vegetation at one time or another during the 10-year survey and on average detected on 36% of the points each year. The number of quail counted in both the myrtle shrub and loblolly forest BBS routes has shown an increasing trend between 1996 and 2006 (unpubl. data, Refuge files).

Four woodcock singing survey routes (totaling 40 survey points) encompass all suitable woodcock habitat on the Refuge accessible by road. Routes have been run intermittently in eight of the past twenty years, beginning in 1990. A maximum of 15 woodcock were detected during the 2000 survey, and the most recent survey in 2009 counted 5 woodcock. Birds have been counted on each route with the exception of the North Service Road. Beach Road/Woodland Trail has had the highest number of detections and been the most consistent in having woodcock over

the years. The Swan Cove/Wildlife Loop did not have any woodcock during the first ten years of the survey but has had more woodcock than any other route during the most recent decade. It was the only area with singing woodcock in 2009. No long-term trend can be determined from the data except that higher numbers of woodcock were counted during the first half of March, irrespective of the year. Counts after March 21 generally detect fewer birds, perhaps indicating that Chincoteague is more important to migrating or wintering woodcock than breeding birds. Wallops Island NWR appears to have suitable habitat but lacks survey data.

The first turkeys on Assateague Island were sighted in March 2005. LE Officer Fair observed two turkeys by the fee booths near the refuge entrance. Coincidentally, the NPS staff reported turkeys on the north end of Assateague Island around the same time. Turkeys are regularly encountered on the bi-weekly waterfowl survey. The population size of turkeys is unknown, but a flock no greater than 20 birds (adults and juveniles) was observed in December 2009 (Buffa, pers. obs.). Turkeys are thought to be at least stable and probably increasing (Refuge unpubl. data).

Mammals

The historic range of the federally endangered Delmarva Peninsula fox squirrel (hereafter, Delmarva fox squirrel or DFS) (*Sciurus niger cinereus*) did not encompass the barrier islands in Virginia. To encourage species recovery, 34 DFS from Blackwater NWR and Eastern Neck NWR (both located in Maryland) were translocated to Assateague Island from 1968-1971 (USFWS 1993). The population has increased and expanded from the initial release sites on Lighthouse Ridge and Headquarters areas to all suitable loblolly pine habitats on the Refuge. The population is considered stable and estimated at 200 animals. Management consists of maintaining nest boxes, mowing roadside grasses to reduce vehicle/DFS collisions, thinning forest understory, and monitoring/controlling southern pinebark beetle outbreaks when they threaten habitat. Population estimates are made biannually with mark-recapture techniques.

A small but stable population of native white-tailed deer (*Odocoileus virginianus*) is present on Chincoteague and Wallops Island NWRs. They are managed through a regulated hunt program on Assateague Island, Wildcat Marsh, and WINWR to maintain populations at levels that are compatible with Refuge habitat objectives, and to provide recreational hunting opportunities (CNWR 2007 a & b). Some white-tailed deer also use Cedar and Assawoman Islands, as evidenced by tracks and scat.

A small number of sika elk (*Cervus nippon*), a species native to east Asia and Japan, were released on the northern end of Assateague (MD) in the 1920s when the island was privately owned (Flyger 1960). They increased in number and expanded their range to occupy the entire island, and sika were well established on the Virginia end of the island when CNWR was established in 1943. By 1963 the sika population was estimated at 1,300, and a browse line was becoming evident on Refuge vegetation, indicating an over-population (Refuge Narratives). Public hunting, started in 1964, has continued to the present with objectives of reducing an exotic animal, preventing habitat degradation, and providing a public recreational opportunity.

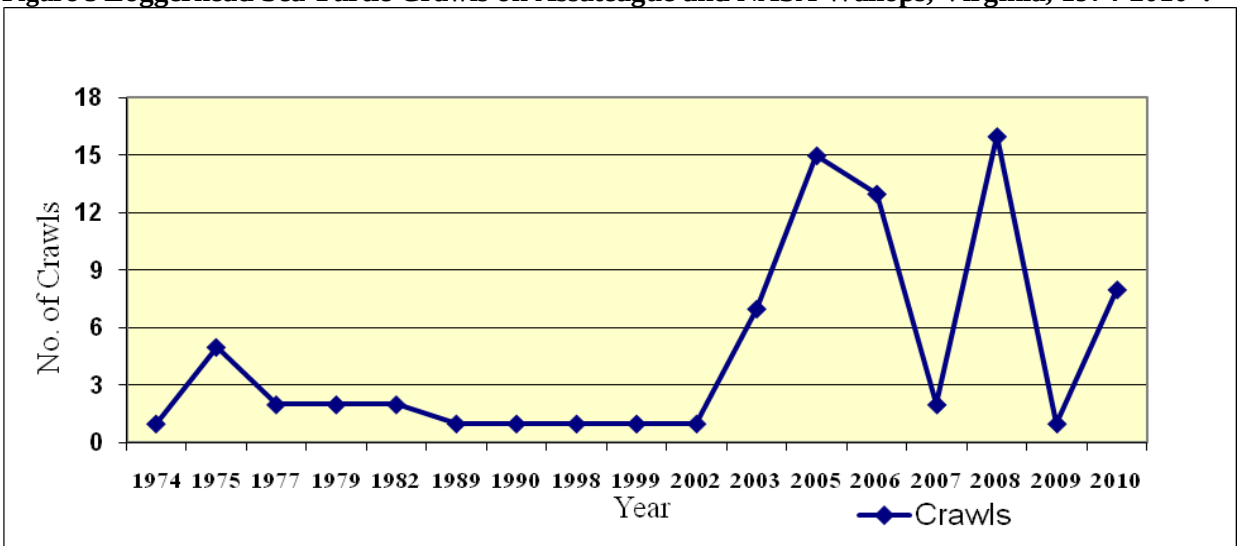
The population of sika on the CNWR portion of Assateague Island was estimated at 1,000 animals in the mid-1990s using a model combined with spotlight surveys (Bicksler et al. 1995). The minimum population estimate for sika in the fall of 2007 and 2008 was 600 animals based on CNWR harvest data and the Downing population reconstruction model (Davis et al. 2007). Each year harvest data and staff observations of habitat conditions are evaluated to determine season lengths, hunt areas, and bag limits needed to control the herd and keep deer and elk from causing resource damage.

Red fox (*Vulpes vulpes)*, non-native to the barrier islands, and raccoon (*Procyon lotor*) are selectively controlled through a trapping program to minimize their predation on nesting piping plovers, American oystercatchers, terns, and skimmers (USDA 2005). Other mammals common in suitable habitat include Virginia opossum (*Didelphis virginiana*), eastern cottontail (*Sylvilagus floridanus*), river otter (*Lutra canadensis*), least shrew (*Cryptotis parva)*, as well as several species of bats and rodents. Bottlenose dolphins (*Tursiops truncates*) are commonly seen from shore, and several species of seals and whales are found washed ashore throughout the year.

Reptiles and Amphibians

The federally threatened [4]loggerhead sea turtle (*Caretta caretta*) nests on Assateague Island, which is the northern extent of its breeding range. Crawl and nesting activity occurs June through August, but activity tends to occur every other year (unpubl. data, Refuge files). Because incubation takes longer (90 or more days) at this latitude, the hatch window is August through October. Nesting activity on Assateague and NASA Wallops Islands has risen noticeably in recent years (Figure 5), perhaps the result of a loggerhead translocation project. From 1969 -1979 sea turtle eggs from nests laid on Cape Island of Cape Romain National Wildlife Refuge, Charleston County, SC were translocated to CNWR. During, and the first two decades following, the relocation program (1970 – 1999) staff recorded 16 crawls on Assateague and NASA Wallops; ten resulted in nests and six were false crawls, meaning no nest was made. Loggerhead nesting activity from 2000 – 2010 had a total of 62 crawls; 22 resulted in nests and 40 were false crawls. Loggerhead sea turtles take 30 years to reach maturity, so females that were part of the transplant project may now be returning to their hatch and release sites.

Figure 5 Loggerhead Sea Turtle Crawls on Assateague and NASA Wallops, Virginia, 1974-2010*.



***Only years with crawl incidents are shown.**

The Virginia Sea Turtle Crawl Database 1997-2009 (Unpubl. database maintained by VDGIF) lists one loggerhead sea turtle false crawl on Assawoman Island (2005) and one loggerhead nest on Cedar Island (2007). The Cedar Island nest is noteworthy because it resulted in the best hatch success (96%) of sea turtles recorded for Virginia's barrier islands (VDGIF unpubl. database). Loggerhead nesting activity may be more common on the southern barrier islands than noted in this database. For example, Cedar Island appears to have substrate favored by sea turtles for

[4] At time of writing, the loggerhead sea turtle is proposed for uplisting to Endangered in the Federal Register.

nesting, but since the island is visited far less frequently than Assateague, crawls and nests may go undetected (Amanda Daisey, CNWR Biologist, pers. comm.).

Three other species of sea turtles (Atlantic green (*Chelonia mydas mydas*), Atlantic ridley (*Lepidochelys kempi*), and leatherback (*Dermochelys coriacea*) use waters off-shore the Refuge. Dead stranded turtles of these species are occasionally found on CNWR beaches, but nesting has not been documented.

Twenty other amphibian and reptile species have been recorded on Assateague Island (Appendix 6) during surveys conducted on Assateague Island by Toadvine (2000), Mitchell et al. (1993), Conant et al. (1990), and other refuge monitoring studies. Included are 6 species of snakes, 11 species of turtles, 6 species of frogs and toads, and one salamander species. The herptofauna on other Refuge barrier islands and WINWR has not been investigated.

The northern diamondback terrapin (*Malaclemys terrapin terrapin*), a Tier II species in Virginia (Appendix 1), dwells in Refuge salt marshes. Female terrapins lay eggs on beach habitats (i.e., berms, dunes, and washover sand flats) of Assateague, Assawoman, Cedar, and Metompkin Islands from early June through early August (Feinburg and Burke 2003). A 3-year study (2006-2008) of terrapins nesting on south Cedar Island found that egg-laying peaks in June and tapers off in late July; predation followed by wash-out are the leading causes of mortality (Boettcher, unpubl. data). Predators (ghost crabs and red fox) destroyed 94% of nests in 2006 and only 38% in 2007, following the implementation of a predator control program (Boettcher, unpubl. data). Raccoons were not present on Cedar Island during this study, but are considered major predators where they occur on barrier islands (Feinburg and Burke 2003). Therefore, predator control programs to protect beach nesting birds also benefit terrapins.

Of the six frog and toad species, four were commonly encountered by Toadvine (2000) and during aural call count surveys conducted by refuge staff in 2003, 2004, and 2005: Fowler's Toad (*Bufo woodhousii fowler*i), southern leopard frog (*Rana utricularia*), green tree frog (*Hyla cinerea*), and bullfrog (*Rana catesbeiana)*. New Jersey chorus frog (last observed in 1970s at one location near the lighthouse), and green frog (not reported since Conant 1990) may no longer be present on the island. Green frogs occupy permanent bodies of freshwater, and several periods of drought in the 1990s may have eliminated habitat on Assateague Island (Toadvine 2000). Re-colonization is still a possibility (Mitchell et al. 1993 and Conant et al. 1990).

Seven species of snakes are listed as occurring on the Refuge (Appendix 6). Little management-related information is known about them. The black rat snake (*Elaphe obseleta)* may predate Delmarva fox squirrels since it is an excellent climber and often found in squirrel nest boxes.

The red-back salamander (*Plethodon cinereus*) may be becoming more common on the Refuge. Few individuals were found by Toadvine (2000) and Mitchell et al. (1993). A quick survey using the White Hills Delmarva fox squirrel trap line as a sampling transect line in December 2008 found these salamanders to be common under mixed hardwood/loblolly pines with adequate leaf litter, and absent under pure loblolly pine stands with relatively dry sandy substrate and no litter.

Fish

The Refuge has a diverse assemblage of fish species in and around the area. The habitat is important as a nursery area for juveniles and a foraging area for adults. The Refuge manages impoundments for birds, not necessarily for fish, but large numbers of sheepshead minnow (*Cyprinodon variegates*) and mummichogs (*Fundulus heteroclitus*) are present in impoundments that have water control structures with marine connections.

Fisheries surveys were conducted by the USFWS Gloucester Office of Fisheries Assistance in September-October 1996 and by the USFWS Maryland Fishery Resources Office in September-October 2005 and April 2006. Methods of collection and areas surveyed were similar in both surveys. Tidal marine areas and impoundments (B-Pools, F-Pool, North and South Wash Flats, and Old Fields) were sampled during both of these efforts. Several sites were sampled in 1996 but not in 2005/06: Assawoman Island, Cedar Island, and the A-Pool impoundment. The 2005/06 survey added a sampling site in Sow Pond and two additional sites in Virginia Creek.

Forty fish species were collected during these surveys. The 1996 survey collected 36 species while the 2005/06 survey collected 23 species (Appendix 7). Fish collected were all considered common to the area (Mangold and Eyler 2006). Several important fish species were collected during the surveys. American eel (*Anguillia rostrata*), captured during both surveys, are under a status review for ESA listing and a Virginia state conservation plan priority species. Alewife (*Alosa pseudoharengus*), captured in F-pool during 1996, is a Tier IV species in Virginia's State Wildlife Plan (Appendix 1).

(Mangold and Eyler 2006) found good numbers (1,179) of Atlantic menhaden (*Brevoortia tyrannus*), which they considered noteworthy because they are an ecologically important species. They consume plankton and plant detritus and are in turn consumed by important commercial and recreational fish species. Menhaden likely use the area around the Refuge as a nursery.

Other Marine Resources

Horseshoe crabs are economically and ecologically important in the mid-Atlantic region. They provide an important food resource for sea turtles and their eggs are eaten by migratory shorebirds. Horseshoe crabs that spawn in Toms Cove come ashore during high tides in May and June to deposit their eggs in shallow nests on Refuge beaches. A recent mark-recapture study has found that the Toms Cove horseshoe crab population is demographically linked to Delaware Bay. Delaware Bay is an important staging area for the imperiled red knot, which depends on horseshoe crab eggs in that bay to fuel its northern migration (see previous section).

Invertebrate

Assateague Island is an important stopover area for fall-migrating monarch butterflies (*Danaus plexippus*). Refuge habitats provide an abundance of nectar sources such as goldenrod (*Solidago sempervirens, S. graminifolia* and *S. tenuifolia*), climbing hempweed (*Mikania scandens*), large bur-marigold (*Bidens laevis*), groundsel-tree, and horsemint (*Monarda puctata*), which fuel the monarch's journey to wintering sites in Mexico. Important night-roosting sites are located in thickets of bayberry, wax myrtle, groundsel-tree, and eastern red-cedar in the vicinity of Toms Cove and along the Service Road (Gibbs 2008).

Peak migration usually occurs during the last week of September and the first week in October, with a second wave occurring during mid-October in some years. In most years there are three peaks or "waves" of monarchs. The waves most often occur after the passing of a cold front, and large waves also occur after hurricanes (Gibbs 2008).

Wilderness

Portions of the Assateague Island Wilderness Proposal are located within CNWR. The proposal includes 882 acres of lands just south of the Maryland/Virginia state line, extending from mean low water (MLW) along the Atlantic Ocean to MLW along Chincoteague Bay. Congress has not yet acted on the proposal.

Chapter 3. Resources of Concern

- Potential Resources of Concern
- Biological Integrity, Diversity, and Environmental Health
- Priority Resources of Concern
- Priority Habitat Types and Associated Focal Species
- Conflicting Habitat Needs
- Adaptive Management

3.1 Potential Resources of Concern

The Habitat Management Plan policy (620 FW 1) defines resources of concern as, "All plant and/or animal species, species groups, or communities specifically identified in Refuge purpose(s), System mission, or international, national, regional, State, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are resources of concern on a Refuge whose purpose is to protect migrating waterfowl and shorebirds. Federal or State threatened and endangered species on that same Refuge are also a resource of concern under terms of the respective endangered species acts."

Given the multitude of purposes, mandates, policies, regional and national plans that can apply to a Refuge (see Chapter 1.2 and 1.3), there is a need to prioritize those resources that the Refuge is best suited to focus its management objectives on. This chapter documents the process used to identify priority resources of concern, priority habitats and focal species.

Trust resources for which the USFWS has full responsibility include migratory birds, endangered species, inter-jurisdictional fish, certain marine mammals, and the land and waters administered for the management and protection of these resources. Virginia's Comprehensive Wildlife Conservation Strategy (2005) identifies wildlife species in the state that are the highest priority for conservation. These federal and state lists received emphasis in developing the Refuge's resources of concern.

Beginning with a Regional Biological Review of Delmarva Peninsula Refuges in October 2006, Refuge staff began identifying Refuge-specific challenges and opportunities, and species of management focus. In February 2009, a meeting of technical experts from organizations, other agencies, and other FWS program areas helped further refine habitats and species of concern. One-on-one meetings with stakeholders, and a review of numerous conservation plans and documents focusing on the Mid-Atlantic Region, the Delmarva Peninsula, and Virginia barrier islands further assisted this process. Refuge surveys, databases, studies, and reports provided substantial information. Finally in February 2010, 25 technical experts from government agencies, organizations, and individual researchers met to review the draft HMP. Their input resulted in changes to the focal species selected (Table 3.2) and revisions to this HMP.

The result of this process is Appendix 1. It is a matrix of potential resources of concern for Chincoteague and Wallops Island NWRs based on occurrence, habitat availability, and population trends. Species in Appendix 1 are of local, state, regional, or national conservation concern, whose range and habitat requirements potentially encompass both Refuges.

3.2 Biological Integrity, Diversity, and Environmental Health

The 1997 National Wildlife Refuge System Improvement Act states that in administering the System, the USFWS shall "… ensure that the biological integrity, diversity, and environmental health of the System are maintained…" (USFWS 2003). The Service (2003) defines these terms as:

Biological Diversity The variety of life and its processes, including the variety of living organisms, the genetic differences between them, and the communities and ecosystems in which they occur.

Biological Integrity Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.

Environmental Health Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.

In addition to providing habitat for trust species, refuges support other elements of biodiversity including invertebrates, rare plants, unique natural communities, and ecological processes (USFWS 1999). Where possible, Refuge management restores or mimics natural ecosystem processes or functions and thereby maintains biological diversity, integrity, and environmental health. Given the continually changing environmental conditions and landscape patterns of the past and present (e.g., rapid development, climate change, sea level rise), relying on natural processes is not always feasible nor always the best management strategy for conserving wildlife resources. Uncertainty about the future requires that the Refuge manage within a natural range of variability rather than emulating an arbitrary point in time. This maintains mechanisms that allow species, genetic strains, and natural communities to evolve with changing conditions, rather than necessarily trying to maintain stability.

The Integrity Policy (Meretsky et al. 2006) directs refuges to assess their importance across landscape scales and to "forge solutions to problems arising outside refuge boundaries." Some of these regional land use problems include habitat fragmentation and lack of connectivity, high levels of contaminants, and incompatible development or recreational activities.

Appendix 3 summarizes the existing elements of biological integrity, diversity, and environmental health (BIDEH).

3.3 Priority Resources of Concern

The potential resources of concern table (Appendix 1) contains a large number of species. To objectively reduce the list to a manageable number and focus efforts where the Refuge can contribute most to conservation efforts, a list of Priority Resources of Concern was developed by habitat type. Table 3.1 was developed using the following approach and filtering criteria:

- Federal and State listed Threatened and Endangered species were automatically included in Table 3.1.

- The Bird Conservation Region (BCR) plan for BCR 30 ranks and prioritizes migratory birds most in need of management of conservation focus for the New England/Mid-Atlantic Coast Region. Although all species on the BCR 30 priority list need conservation attention, we selected species ranked highest (HH) or high (H) in BCR 30.

- Birds and other wildlife species listed in the Virginia Comprehensive Wildlife Conservation Strategy (commonly referred to as the "State Wildlife Plan") and plants on the Virginia Department of Conservation and Recreation (DCR) natural heritage database received additional weight. For example little blue heron is a Moderate BCR priority, but a Tier II (very high conservation need) species in the State Wildlife Plan, so it was included in Table 3.1.

- Relative abundance or frequency of occurrence on the Refuge. Some BCR 30 highest or high priority species occur infrequently, or in low numbers in comparison to their population size, and were therefore not included on Table 3.1. Examples are Ipswich sparrow, blue-winged warbler, and marbled godwit.

Table 3.1 Priority Resources of Concern by Habitat for Chincoteague & Wallops Island NWRs

Habitat	Species		Assateague Is/ Wildcat Marsh/ Morris Is	Assawoman	Metompkin	Cedar	Wallops NWR
Beach/Dunes	***birds***	American Oystercatcher	B,Y	B,Y	B,Y	B,Y	
		Black Skimmer	B	B	B	B	
		Black-bellied Plover	M,W	M,W	M,W	M,W	
		Common Tern	B,M	B,M	B,M	B,M	
		Dunlin	M,W	M,W	M,W	M,W	
		Gull-billed Tern	B		B	B	
		Least Sandpiper	M	M	M	M	
		Least Tern	B	B	B	B	
		Piping Plover	B/M	B,M	B,M	B,M	
		Red Knot	M	M	M	M	
		Ruddy Turnstone	M	M	M	M	
		Sanderling	M,W	M,W	M,W	M,W	
		Semipalmated Sandpiper	M	M	M	M	
		Short-billed Dowitcher	M	M	M	M	
		Whimbrel	M,W	M,W	M,W	M,W	
		Willet	B,Y	B,Y	B,Y	B,Y	
		Wilson's Plover	B	B	B	B	
	reptile	Loggerhead Sea Turtle	B	P	P	B	
		Green, Leatherback, Ridley	P	P	P	P	
		Northern Diamondback Terrapin	B,Y	B,Y	B	B,Y	
	inverts	Monarch Butterfly	M	M	M	M	
	plant	Seabeach Amaranth	Y	P	P	P	
Impoundments	***birds***	American Black Duck	B,M,W				
		Bald Eagle	B,Y				
		Black-crowned night heron	Y				
		Colonial waterbirds (tricolored, little blue heron, glossy ibis, snowy egret)	Y				
		Shorebirds (least, semipalmated & pectoral sandpipers, short-billed dowitcher, dunlin	M				
		Terns (least, Forster's, gull-billed; black skimmer)	F				
		Waterfowl (bufflehead, Am. wigeon, teal, pintail, mallard, gadwall, scaup)	W,M				
		Snow Goose	W,M				
		Tundra Swan	W, M				
		Wood Duck	B,M				
		Yellowlegs, Lesser & Greater	W,M				
	inverts	Monarch Butterfly	M				
	fish	American eel	juv.				
		Alewife	juv.				
Forested Uplands	***birds***	American woodcock	B,Y				B,Y
		Bald eagle	B,Y				B,Y
		Brown-headed nuthatch	B,Y				B,Y
		Chuck-will's-widow	B				B
		Northern Bobwhite	B,Y				B,Y
		Yellow-billed cuckoo	B				B

Habitat	Species		Assateague Is/ Wildcat Marsh/ Morris Is	Assawoman	Metompkin	Cedar	Wallops NWR
		Breeding landbird suite (Eastern Wood-Pewee, Ovenbird, Great-crested Flycatcher)	B,M				B,M
	mammals	Delmarva Fox Squirrel	Y				P
Shrub / early successional (Maritime Dune Shrub)	***birds***	American Woodcock	B,Y				B,Y
		Brown Thrasher	B,Y			B,Y	B,Y
		Eastern Kingbird	B			B	B
		Eastern Towhee	B,Y			P	B,Y
		Field Sparrow	B,Y			B,Y	B,Y
		Gray Catbird	B,Y			B,Y	B,Y
		Northern Bobwhite	B,Y				B,Y
		Northern Harrier	B,W			B,W	Y
		Prairie Warbler	B			B	B
		Yellow Warbler	B			B	B
		Yellow-breasted Chat	B			M	B
		Neotropical migrant landbird suite (black-and-white warbler, Baltimore oriole, Canada warbler, northern parula, worm-eating warbler, rose-breasted grosbeak)	M			M	M
	herps	Eastern Spadefoot Toad					
		Eastern Tiger Salamander					
	inverts	Monarch Butterfly	M	M	M	M	M
Salt Marsh	***birds***	American Black Duck	B,M,W	B,M,W	B,M,W	B,M,W	B,M,W
		Atlantic Brant	M,W	M,W	M,W	M,W	M,W
		Bald Eagle	B,Y	Y	Y	Y	B,Y
		Common, Forster's Tern	B,M	B,M	B,M	B,M	B,M
		Clapper Rail	B,Y	B,Y	B,Y	B,Y	B.Y
		Colonial waterbirds (glossy ibis, little blue & tricolored heron, snowy egret)	B,Y	Y	Y	Y	Y
		Nelson's Sharp-tailed Sparrow	M,W	M,W	M,W	M,W	M,W
		Saltmarsh Sparrow	B,Y	B,Y	B,Y	B,Y	B,Y
		Seaside Sparrow	B,Y	B,Y	B,Y	B,Y	B,Y
		American Oystercatcher	B,M,W	B,M,W	B,M,W	B,M,W	B,M,W
		Shorebirds (least, semipalmated & pectoral sandpipers, short-billed dowitcher, dunlin,)	M,W	M,W	M,W	P	M,W
		Waterfowl (bufflehead, white-wing and surf scoter, scaup, ruddy duck)	W,M	W,M	W,M	W,M	M,W
		Snow Goose	W,M	W,M	W,M	W,M	
	fish	American eel	Y	P	Y	Y	Y
		Alewife	Y	P	?	P	P
		American shad	P	P	P	P	P

B=breeding, M= Migratory; W=Wintering, Y=Year round, F= Feeding, P= Not confirmed on Refuge, but has suitable habitat, and found in adjacent area; juv= Nursery habitat

Sources for Table 3.1: Roberts 2009; CNWR CENSUS waterfowl, shorebird, waterbird, raptor database; Christmas Bird Count data; VDGIF Fish and Wildlife Information Service (online); Ruth Boettcher, VDGIF Biologist, pers. comm.

3.4 Focal Species

The next step was selecting focal species (Table 3.2). Focal species are highly associated with important habitat attributes and were selected to represent the needs of a guild of species that use the same habitat and respond to management similarly. Using focal species simplifies the development of goals, objectives, and strategies while at the same time addressing important components of functional, healthy ecosystems (USFWS 2008b). The **following filters** were used to select focal species.

- **Site capability:** Habitat conditions on or surrounding the Refuge were evaluated for their ability to support or enhance populations of the species. The following site-specific factors were evaluated:
    - Documented occurrence on the Refuge
    - Habitat connectivity
    - Environmental conditions: soils, hydrology, disturbance patterns, predation, invasive species
    - Specific life history needs

  Data from long-term monitoring such as waterfowl and shorebird surveys, as well as Robert's landbird mist-netting annual reports, Gibbs' (2008) migrating monarch study, breeding bird survey data-sets, and other unpublished reports in Refuge files were used in the selection of focal species. Applying this criterion, the monarch butterfly was selected as a focal species because of the Refuge's importance as a migratory stopover. Conversely, all sea turtles other than loggerhead were eliminated because nesting has only been documented for the loggerhead sea turtle on the Refuge.

- **Predicted management response:** The likelihood that a potential focal species, or habitat upon which it depends, would have a positive reaction to management strategies. Applying this criterion, Atlantic brant were ruled out as a focal species because few opportunities exist to enhance habitat or conduct other management actions that will benefit the species. Prairie warbler was selected as a focal species because this highest priority BCR 30 species responds to how the myrtle/bayberry shrub habitat is managed on the Refuge (Roberts 2009).

- **Ecological and Ecosystem Processes:** How well a potential focal species represents ecological (internal factors responsible for Refuge habitats such as nutrient cycling, hydrology, soils) or ecosystem (external drivers such as watershed variables, climate change) processes within the refuge and surrounding landscape. Applying this criterion, saltmarsh sparrow and clapper rail were included as focal species. Even though distribution, population size, and other parameters of the clapper rails on CNWR are poorly understood at present, rail and saltmarsh sparrow breeding habitat is most at risk from climate change and sea level rise.

- **Guild approach:** The likelihood that a species would represent the needs of a larger guild of species. Applying this criterion, short-billed dowitcher was selected as a focal species representing the foraging habitat requirements of medium to large shorebirds, dunlin was selected to represent the foraging habitat needs of small shorebirds, and northern pintail was selected to represent wintering waterfowl that feed in impoundments.

Table 3.2 Focal species, habitat requirements and other benefiting species: Chincoteague and Wallops Island NWRs.

Focal Species	Habitat Type	Habitat – Vegetation Structure	Other Target Species that Benefit from Habitat Management
Piping Plover	**Beach/ Dunes**	Nest above the high tide line on open sand, gravel or shell-covered beaches, especially on sand spits and blowout areas in dunes. Feed in tidal pools, intertidal at low tides & wrack piles at high tide line	Breeding shorebirds (e.g.. American oystercatcher, black skimmer, Wilson's plover, common tern, black skimmer)
Least Tern		Nest on open sand, gravel, or shell-covered beaches above the high tide line	
Sanderling		Winter & Migration: Feeds in swash zone of sandy beaches at mid and high tide primarily on molecrab (*Emerita talpoida*). If available, moves to sandflats as tide recedes (Morton 1996)	Winter foraging shorebirds (e.g., American oystercatcher, black-bellied plover, dunlin, willet)
Red Knot		Migration and feeding on sandy beaches, especially during spring migration. Use peat banks on bayside of southern islands. Feeds primarily on clams and crustaceans on Virginia's barrier islands.	Spring and fall migrants (e.g. dunlin, least & semipalmated sandpiper, marbled godwit, ruddy turnstone, semipalmated plover, whimbrel, Caspian and other migrant terns)
Loggerhead Sea Turtle		Nest on Assateague Island between high tide and dune line; Not recorded every year.	Diamondback terrapin
Seabeach Amaranth		Open, sparsely vegetated beaches with low plant diversity, including overwash areas. Only recorded for Assateague Is. thus far (mostly Wild Beach)	Tiger beetle (*Cicindela dorsalis media*), goldenrod, seaside knotweed (*Polygonum glaucum*),
American Black Duck	**Impoundments**	Impoundments used for loafing, resting, thermal cover, and protection from hunting. Coastal salt marsh and lagoons behind barrier beaches and islands important for feeding.	Migrating & wintering ducks, snow geese, tundra swan. All frog, toad & turtle species.
Northern Pintail		Migration (peaks November) and wintering habitat. Shallow flooded (<12" water depth) seed producing moist soil vegetation (e.g. spike rush, smartweed) used for feeding.	Migrating & wintering waterfowl, particularly those that use impoundments for feeding; bald eagle.
Short-billed Dowitcher		Shallow (<12 cm water depth) to mudflat habitat with sparse to no vegetation (<15% cover), at the time of peak shorebird migration (late May and late August).	Other small and medium-sized shorebird species. Monarchs use *Bidens,* goldenrod, and saltmarsh fleabane in impoundments for nectaring.
Dunlin		Shallow water (0-5 cm. deep); feeds on arthropods, bivalves, amphipods, and insects (Warnock and Gill 1996). Feed in impoundments and in tidal mudflats (Refuge unpubl. data).	
Snowy Egret		Breeds colonially on ground/short bushes in bay marshes & feeds in impoundments, where low summer water levels concentrate prey items.	Little blue & tri-colored herons; great egret; glossy ibis; common & gull-bill terns
Delmarva Fox Squirrel	**Forested Uplands**	Open park-like forest of mature (>30 cm dbh) loblolly pine with oaks and other hardwoods. Feed on mast, pine cones & underground fungus	Other cavity-nesters such as great-crested flycatcher and owls, and canopy-nesters like eastern wood-peewee, will benefit from

Focal Species	Habitat Type	Habitat – Vegetation Structure	Other Target Species that Benefit from Habitat Management
Brown-headed Nuthatch	**Forested Uplands**	Occurs exclusively in pine forests; nests and roosts in snags; forages in live pines. Prefers forests w/ small clearings created naturally (wetland ecotones, disease or fire) or artificially (small clear-cuts). (Withgott and Smith 1998)	habitat structure preferred by nuthatches. Good habitat for towhees also favors landbirds needing understory vegetation, such as ovenbird and chuck-will's-widow.
Eastern Towhee		Forests with dense ground cover. Nests and feeds on ground. Eats fruits, seeds, buds, and insects. (Greenlaw 1996).	
Brown Thrasher	**Shrub/ early successional**	Dense, wax myrtle/bayberry shrub and greenbrier habitat; early successional forests & bordering impoundments and utility rights-of-way. Nests in vines or shrubs, especially w/ thorns; sometimes small trees (Cavitt and Haas 2000).	Breeding birds such as eastern towhee, field sparrow, yellow warbler, yellow-breasted chat, gray catbird, and migrants including black-and-white, worm-eating & Canada warbler; northern parula, Baltimore oriole, rose-breasted grosbeak.
Prairie Warbler		On Assateague suitable habitat found in tall (3-3.5 meter) wax myrtle & bayberry shrub community between the dunes and the impoundments (Roberts 2009) and powerline ROW on WINWR (Cooper 2000). Breeds in brushy dune communities (Cooper 2000). Needs absence of trees and a continuous block of mature shrub (Roberts 2009).	
Neotropical Migrant Landbirds		Mature stands of wax myrtle, bayberry, groundsel tree, beach heather, blueberry and other forbs growing on the backside of dunes and impoundment dikes provide key stopover for southbound fall migrants to refuel.	
Northern Bobwhite		Early successional stages of loblolly and mixed pine/ hardwood forests, and forest edge adjacent to shrub habitats and old fields. Feed on seeds of annual plants.	American Woodcock
Monarch Butterfly		Bayberry, groundsel trees, & eastern red cedar thickets along Toms Cove and the Service Rd. provide roost sites. Seaside goldenrod is the most important nectaring plant; Other goldenrod species, groundsel-tree, & climbing hempweed are also nectar sources (Gibbs 2008).	Native bees and other pollinators
Whimbrel	**Salt Marsh (includes mudflats and pannes)**	Feed on tidal mudflats at low tide and roost in salt marsh at high tide (Skeel and Mallory 1996). Feeding activity related to tidal cycle, peaking at 2 hours after low tide for most species (Burger et al. 1977)	Shorebirds that feed on mudflats including black-bellied plover, short-billed dowitcher, semi-palmated sandpiper and plover, greater yellowlegs, marbled godwit.
Clapper Rail		*Spartina alterniflora* marshes with scattered shrubs (*Iva frutescens)* along tidal creeks. Forages in emergent vegetation, slough channels and mudflats at low tides. Eats crustaceans.	Ground nesters (black skimmer, gull-billed tern, common tern) and colonial nesters (herons, egrets, ibis)
American Oystercatcher		Nests on salt-marsh islands, storm-deposited shell piles on their perimeters, and barrier island beaches (Rounds et al. 2004).	
Saltmarsh Sparrow		Nest in large (≥50 hectares) patches of high marsh dominated by *Spartina patens* (Paxton 2007). Forage in low marsh *(S. alterniflora, Distichlis spicata)* on aquatic and terrestrial invertebrates (CCB 2010).	Seaside sparrow, wintering Nelson's sharp-tailed sparrow, willet, northern harrier

- **Regional Rank:** The relative potential of CNWR or WINWR to conserve a particular species of conservation concern in comparison to other National Wildlife Refuges in Region 5. Appendix 4 was used as a tool to apply this criterion for breeding landbirds. CNWR was ranked first, second, or third for the proportion of brown-headed nuthatch, brown thrasher, chuck-wills-widow, eastern towhee, field sparrow, bobwhite, and yellow-breasted chat counted during Breeding Bird Surveys on Region 5 refuges. The nuthatch and towhee, representative of forested uplands, and thrasher and bobwhite, representative of shrub/early successional, were selected as focal species.

3.5 Conflicting Habitat Needs

Given the diversity of goals, purposes, and mandates for the NWRS, it is not uncommon to have conflicts over management decisions on a Refuge. Balancing the types and proportions of habitat conditions on the Refuge requires a thoughtful and documented process for determining the best course of action. Chincoteague NWR has several management decisions that require such an approach.

Impoundment Management, Dune Stabilization, and Barrier Island Process
Artificial dunes erected on Assateague Island to stabilize the beaches, dikes, and roads allowed the creation of impoundments. Impoundments in turn provided important habitat for waterfowl and shorebirds. However, the artificial dunes and other beach stabilization efforts (e.g. dune repair, beach parking lot maintenance) altered the natural barrier island processes. The stabilized dunes helped to decelerate barrier island migration, accelerated erosion of the shoreline along Wild Beach, and increased shrub and other woody vegetation behind the dunes (Applied Biology 1980).

Some impoundments, such as North and South Wash Flats, were constructed in natural overwash areas. Artificial dunes decreased overwash habitat preferred by certain beach-nesting species like piping plover and least tern and, along Wild Beach (Figure 6), probably decreased the amount of beach and foredune habitat used by other beach nesting species like American oystercatchers. As waves naturally erode the sandy beach in the Wild Beach area, the beach and dunes cannot naturally migrate inland following the natural process of barrier island rollover and migration. Thus, in order to preserve infrastructure that supports habitat for waterfowl and shorebirds, the Refuge entered into a cycle of countering beach erosion and repairing infrastructure, which conflicted with the needs of other shorebird species.

Whether, when, and where to restore natural processes is a challenging and complex management problem. As sea-level rises, management and maintenance of Assateague Island's impoundments will become increasingly challenging and expensive. Conversely, they may also become more important as tidal marshes are inundated. Predicted changes to the landscape and wildlife populations coupled with the evolution of regional and Refuge wildlife population objectives presents a moving target. Like other refuges in the Region, Chincoteague maintains impoundments because their enhanced habitat values help fulfill Refuge purposes (See Section 1.2). Alternatively, coastal impoundments may be restored or allowed to revert to non-impounded natural marsh habitats thereby benefitting a different suite of wildlife species. Public recreation and demand further complicate the issue. Refuge visitors expect to see large concentrations of birds that are frequently observed and photographed within the Refuge's impoundments. Some impoundment dikes, including portions of Beach Road and the Wildlife Loop, provide access to the beach and other wildlife viewing opportunities.

As sea level rise occurs, or severe storms increase in frequency, greater costs will be associated with maintenance of these impoundments. At some point in time, the costs of maintaining Refuge impoundments may exceed the benefits and/or be cost prohibitive. In 2009 Chincoteague and several other coastal Refuges used a Structured Decision Making (SDM) process to develop a consistent framework that could be applied to decide when to maintain or restore an individual impoundment into an alternative habitat type.

The SDM process helps identify considerations other than costs that need to be factored in when deciding whether it is no longer viable to maintain an impoundment. Factors identified thus far in the SDM process (still underway when this HMP was being prepared) include:

- Is the impoundment necessary for maintaining a population at a landscape scale?
- Is the impoundment critical to achieve the primary purpose of the refuge?
- What is the role of the impoundment in the annual cycle – does it provide habitat that is not otherwise available within the flyway scale or within the daily flight distance of a focal species?
- Are there alternative sites within the area providing that habitat?
- Is the impoundment restricting salt marsh migration to adjacent natural areas?
- Is beach erosion threatening the impoundment?
- Is the expected natural habitat type, post impoundment, an eco-regional priority?
- When a decision is made to abandon an existing impoundment, subsequent decisions will include how to restore the existing impoundment back to a natural vegetation community.

Outcomes of the Coastal Impoundment SDM will be used to guide objectives and strategies for wetland management in the HMP and CCP.

Recreational Beach Use

Legal mandates to provide public recreation and related facilities on Refuge beaches (Public Law 85 57, Assateague Island National Seashore Act of 1965, and others; See Section 1.2 above) conflict with other mandates to protect wildlife and habitat. Over the years, management programs to balance these two objectives have evolved, and the process continues through the formulation of this HMP and eventually the CCP.

The heaviest beach use occurs in summer, and the majority of important nesting areas are closed to most types of public use during the bird breeding season. Public use (swimming, sunbathing, fishing, and parking) is concentrated in 5.5 linear km. from the south parking lot to D-Dike (Figure 6). North Wash Flats Impoundment is intensively managed to create piping plover nesting habitat to mitigate impacts from this public use and to mimic natural processes which occurred before the artificial dunes were constructed. Public recreation on Metompkin and Assawoman Islands during the nesting season is restricted to avoid sensitive wildlife habitat.

Seasonal off-road vehicle (ORV) use, including night use, is allowed on the 8 kilometers of Assateague south of the beach parking lots (Fig 4) September 1 - March 15; primarily uses are surf fishing, shell-collecting, sunbathing, and recreational driving. ORV use is allowed on part of the Overwash Area (Figure 6) year-round except for complicated intermittent closures during the time when fledgling birds are present. (USFWS 2008c)

Shell collection poses a minor, but currently manageable conflict with wildlife habitat since shells camouflage plovers and other beach nesting birds from predators. Visitors are currently allowed to collect and remove a quantity not exceeding one gallon bucket of shells from Refuge beaches each day. This level of removal seems to be consistent with protection of wildlife habitat (as long

as limits are enforced, and not raised), since collection occurs during the non-breeding season and shells are replenished naturally

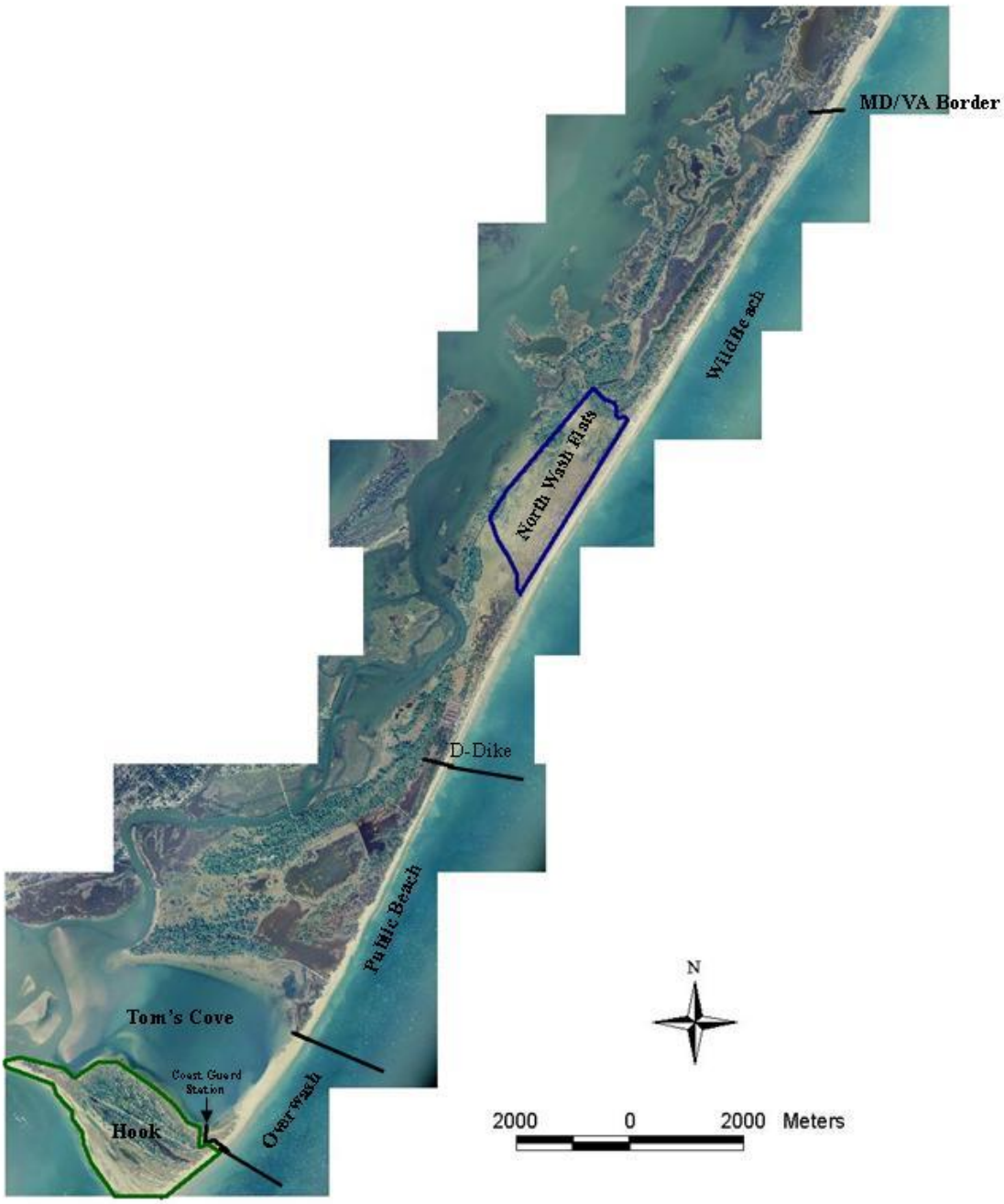
Threats to wildlife and habitat still posed by the existing, albeit limited, public uses include:

- Trespass into closed areas during nesting season, mostly on southern island units
- Beach ORV use during later portion of turtle incubation and hatch window (Sept 1-Nov 1)
- Fall and winter ORV use impacts to migrating and wintering shorebirds
- Attraction of predators, such as gulls, crows, and raccoons, that associate human activity with a food source

3.6 Adaptive Management

The HMP process will develop achievable management objectives and strategies for priority resources of concern based on current knowledge. Many factors, such as lack of resources, existing habitat conditions, species response to habitat manipulations, climate change, contaminants or invasive species, may limit the ability of the Refuge to achieve objectives. Although these limiting factors were considered during the development of Refuge objectives, conditions are likely to change over the next 15 years and beyond. Refuge staff will use adaptive management to respond to changing conditions that affect our ability to achieve objectives set forth in this plan. This requires that staff establish and maintain a monitoring program in order to detect and respond to changing conditions.

Figure 6 Beach Management Areas – Assateague Island (USFWS 2008c)



Chapter 4. Habitat Goals & Objectives

- Coastal Habitats
  Beach Nesting Birds, Shorebirds, Loggerhead Turtle, Seabeach Amaranth, Salt Marsh Nesting Birds
- Managed Wetlands (Impoundments)
  Waterfowl, Shorebirds, Wading Birds, Landbirds, Monarch Butterfly
- Upland Habitats
  Delmarva Fox Squirrel, Eastern Towhee, Brown-headed Nuthatch, Northern Bobwhite, Brown Thrasher, Prairie Warbler, Neotropical Migrant Landbirds, Monarch Butterfly
- Southern Barrier Islands

4.1 Goal 1. Coastal Habitats

Provide quality coastal habitats to support native wildlife, fish and plants by allowing and advocating for the natural dynamics of barrier island geologic processes as part of the Delmarva coastal barrier island system.

Objective 1.1 Beach/Dune nesting shorebirds (ALL islands): Piping Plover and Least Tern
Provide sandy beach, dune edge, washovers, and intertidal areas on Assateague, Assawoman, Metompkin, and Cedar islands, and reduce mortality factors, to maintain a Refuge-wide piping plover fledge rate above 1.2 chicks per pair as averaged over a 10-year period. If fledging rate drops below 1.0 chicks per pair as averaged over a 10-year period, management strategies and prescriptions will be re-evaluated using a formal process and outside expertise.

Rationale: The piping plover (PIPL) is a federal and state-listed threatened species. The least tern (LETE) is a high priority BCR 30 species and Tier II species in Virginia's State Wildlife Plan. American oystercatcher (AMOY), Wilson's plover (WIPL), gull-billed tern (GBTE) and black skimmer (BLSK) are other resources of concern with high rankings (Appendix 1) that nest on Refuge beaches that would benefit from management actions for PIPL and LETE

Even though the Piping Plover Recovery Plan established a region-wide goal of 1.5 chicks per pair (USFWS 1995), the HMP fledge rate goal of 1.2 chicks per pair is based on Hecht and Melvin's (2009) more recent analysis of 1989-2006 region-wide productivity data. Piping plover productivity necessary to sustain or increase populations varies with latitude and in the Southern Recovery Unit, which encompasses CNWR, 0.83 chicks/pair maintains the population (Hecht and Melvin 2009). Overall PIPL productivity in the Southern Recovery Unit was 1.19 chicks/pair in the period analyzed by Hecht and Melvin. This HMP therefore uses the most recent productivity data for the Southern recovery unit: (rounded to) l.2 fledged chicks/pair. This management target allows for population growth necessary to meet recovery goals. If the fledge rate drops below 1.0 chicks per pair (averaged over a 10-year period), management strategies will be re-evaluated through a structured approach such as convening a panel of experts, conducting a structured decision making, or reinitiating consultation with USFWS Ecological Services. Using 1.0 rather than 0.93 PIPL chicks per pair as the trigger to re-evaluate management allows more time to find solutions and implement them

The Refuge-wide average PIPL fledge rate for the most recent 10-year period (2001-2010) is 1.46. Since 1996, the overall trend has been upward (Table 4.1), and the Refuge has one of the highest productivity rates within the Atlantic Coast recovery unit (USFWS 2008c). Productivity has decreased somewhat in recent years; the Refuge-wide average fledge rate for the most recent 5-year period (2005-2009) is 1.13. Natural cycles, climate change and sea level rise are possible causes. Nesting areas were flooded at regular moon tides during summer 2009, flooding many nests before incubation was completed (Refuge unpubl. data).

This HMP does not quantify a productivity goal for LETE because no value has been established for the Atlantic coast least tern population, and high quality habitat that sustains target rates for PIPL will meet the needs for other beach nesting species. Like PIPL, LETE and WIPL require sandy beaches with sparse vegetation that are in close proximity to foraging areas. AMOY, GBTE, and BLSK use similar habitats, but also nest on shell rakes within lagoon systems, sandy bay islands, and high berms within marshes. Over 80% of the state's AMOY population breeds within Virginia's seaside lagoon system (Wilke et al. 2009). Populations of BLSK and GBTE breeding on the Virginia portion of the Delmarva Peninsula represent 80-85 % of all breeding individuals in Virginia, but populations of these species have declined from highs in the late 1970s (Watts and Paxton 2009, Molina and Erwin 2006).

Increases in mesopredators such as red foxes and raccoons on barrier islands from 1977 to 1998 resulted in declines in numbers and colonies of 5 species of terns and black skimmers (Erwin et al. 2001).

Predator control on Assateague Island dates back to the 1950s, but a coordinated, intensive predator removal program on all Virginia barrier islands did not begin until 2000. The doubling of nesting colony sites from 13 in 1998 to 26 in 2008 is probably in large part due to predator removal (Erwin et al. 2001).

Table 4.1 Piping Plover Productivity

Number of piping plover nesting pairs and productivity by year at Chincoteague National Wildlife Refuge, Virginia, 1988-2010.

Year	No. plover pairs	No. plover chicks fledged	Plover fledging rate (chicks/pair)
1988[a]	32	27	0.84
1989[a]	32	36	1.13
1990[a]	42	24	0.57
1991[a]	38	30	0.79
1992[a]	36	19	0.53
1993[b]	41	56	1.37
1994[b]	41	71	1.73
1995[b]	45	44	0.98
1996[c]	51	83	1.63
1997[c]	62	43	0.69
1998[c]	62	69	1.11
1999[c]	55	74	1.35
2000[c]	63	98	1.56
2001[c]	73	134	1.84
2002[c]	76	95	1.25
2003[c]	72	147	2.04
2004[c]	97	221	2.28
2005[c]	118	167	1.42
2006[c]	117	121	1.03
2007[c]	98	110	1.12
2008[c]	117	96	0.82
2009[c]	101	129	1.28
2010[d]	106	159	1.50

[a] Data from Assateague Island. [b] Data from Assateague, Assawoman, and Metompkin Islands. [c] Data from Assateague, Assawoman, Metompkin, and Cedar Islands. [d] Does not include Wallops Island

Objective 1.2 Beach/Dune Habitat for Migrating and Wintering Shorebirds

Over the next 15 years protect and enhance sandy beach and overwash habitat along 21.6 km of Assateague Island (Hook, Overwash, Wild Beach) and tidal flats along Toms Cove to benefit red knots, sanderlings, and other migrating/wintering shorebirds of conservation concern, by regulating and directing public use to less sensitive areas, away from roosting and feeding areas during peak migration.

Rationale: In 1990, the Virginia and Maryland barrier islands were designated as a Western Hemisphere Shorebird Network Site due to the number of shorebirds using the area during migration. During peak spring migration (April and May) tens of thousands of shorebirds stop on Assateague Island to feed and rest (Refuge unpubl. data). Northbound migrants have usually passed through by mid-June. The first of the southbound migrants arrive in early July. Fall migration is more protracted, lasting through September. (Refuge unpubl. data)

Red knot was selected as an umbrella species for shorebirds that use sandy beach and tidal flat habitat during spring migration. Thirty other shorebird species feed and rest here during spring and fall migration including highest priority BCR 30 species such as ruddy turnstone and whimbrel; and high priority BCR species such as dunlin, short-billed dowitcher, semipalmated sandpiper, and marbled godwit (Appendix 1). Sanderling represents the guild of fall migrating shorebirds and is an indicator species of healthy barrier beach wintering habitat. Other wintering shorebirds include American oystercatcher, a BCR highest priority species, and other high priority BCR species such as black-bellied plover and willet.

Chincoteague is a high public use Refuge, and Assateague Island receives around 1.5 million visits annually (Refuge unpubl. data). The majority of this use occurs in the summer from Memorial Day to Labor Day, and most of the beach use is confined to the part of Public Beach area between Swan's Cove Trail and Parking Lot 4 (Figure 6). Seasonal ORV use is allowed on ocean side beaches of the Overwash and Hook; ORV use is not allowed on dunes or vegetated areas. Pedestrian use is allowed yearlong on the Wild Beach, but it is confined to the area below the high tide line during the spring and summer plover breeding season.

Assateague's Hook has been closed to ORV use during the breeding season (March 15 through August 31) since 1988, following listing of the piping plover as threatened under the Endangered Species Act. The Overwash area is closed when chicks are present, typically late May/early June through mid-August. The March 15 through August 31 closure of the 13.5 km long Wild Beach to all recreational uses except walking in the surf zone further minimizes impacts during migration. Appendix 8a lists the allowable public recreational activities by area and season on Assateague Island. These restrictions minimize disturbance to most of the current high quality beach habitat during spring migration and the majority of fall migration, however quality habitat is dynamic. Spring migrating shorebirds using the 2.6 km. length of beachfront habitat in the Overwash are subject to ORV and pedestrian disturbance during peak (April, May) shorebird migration.

Shorebirds using the Overwash and Hook are subject to human disturbance during a portion of peak fall migration (September, and sometimes parts of August in the Overwash). Forgues (2010) found that abundance of sanderlings, ruddy turnstones, willets, black-bellied plovers, and whimbrels on Assateague Island during spring and fall migration significantly declined with higher ORV frequency, and concluded that ORVs can interfere with the ability of shorebirds to accumulate fuel stores for migration. ORV use caused shorebirds on Assateague Island to spend less time foraging, and to avoid areas where ORVs were present (Forgues 2010).

Eight km of the Refuge's 27 km of beach on Assateague Island are open to ORV use during the fall and winter (September 1 – March 14). Morton's (1996) studies of Assateague's wintering shorebirds found that human activity, both pedestrian and vehicular, negatively impacted sanderling use of beach areas, foraging activity, and energetics. Human disturbance caused sanderlings to avoid areas which were otherwise suitable (i.e., had good food resources), flush more, and feed less. This could result in the birds being less fit to make their migration (Morton 1996). A study in Massachusetts found that sandpipers which departed migratory stopover areas at low weights in the fall were less likely to return the following year than birds of higher weights (Harrington and Drilling 1996). Winter is a strenuous time for wildlife because of decreased availability of food and cold temperatures. Sanderlings wintering on Assateague are at the northern edge of their winter range, suggesting that effects of human disturbance may be more harmful to their survival or fitness for migration (Morton 1996).

Nighttime beach use of the public beach and ORV zone currently allowed for surf fishing may adversely impact wintering shorebirds. Morton (1996) found that occurrence of any human activity on beaches at night decreased the likelihood of sanderlings concurrently using the same habitat by 83%.

Objective 1.3 Beach/Dune Habitat for Turtles
Protect a minimum of 21.6 linear km of sandy beach habitat on Assateague Island for nesting loggerhead sea turtles. Continue *in situ* nest protection such that no more than 3 nests over any 5-year period, and no more than one in any given year, are lost to human or predator-related causes.

Rationale: The loggerhead sea turtle is a federal and state-listed threatened species. To date, there has been no confirmed nesting by green or leatherback sea turtles, both federally listed as endangered, within CNWR although both these species have been seen in waters off Virginia's barrier islands during the nesting season. However, with the average global air and water temperatures rising, Refuge beaches may become more favorable for these species (USFWS 2008c). The northern diamondback terrapin (Virginia State Wildlife Plan Tier II species) also nests in sandy beach habitats. Strategies to benefit loggerheads will also enhance habitat conditions for these other turtle species.

Loggerhead females do not reach sexual maturity until 30 years of age. Mature loggerheads nest every two to three years, but an individual female may nest 1 to 6 times in a single nesting year (USFWS 2008c). Virginia is at the northern extent of the loggerhead's present breeding range. Nesting does not occur yearly on the Refuge, and when it does, there are typically only a few nests per year. The sex ratio of hatchling turtles depends on temperature during incubation. When the sand surrounding the nest is below 84^{o} F, more males are produced than females. This is thought to be the case for nests on Assateague Island.

The three main threats to nesting loggerheads on Assateague are: 1) weather and tides, 2) predation, and 3) human activities. The most common cause of nest failure on CNWR has been weather (Refuge files). In the 5-year period encompassing 2005-2009, ten loggerhead nests were found on Assateague. Three of the ten hatched, six were lost to weather-related causes, and the fate of one is unknown. In the previous 5-year period (2000-2004), Assateague Island had only three loggerhead nests; one partially hatched (4% of eggs produced turtles) and the remaining two were lost to weather-related causes. The long incubation period, which is 90 days at this latitude, means nests face a greater likelihood of being washed out by high tides, hurricanes, or other storm events. No turtle nests have been knowingly lost to predators. Management actions, such as mammalian and avian predator removal and placing protective screening over nests may have prevented predation. Also, because sea turtle nests are such a rare occurrence, predators are probably not keyed into and actively looking for sea turtle nests.

Human use of nesting beaches, particularly at night or early morning when females come ashore to nest, can disturb nesting females, prevent egg-laying, and indirectly harm hatchlings. Flashlights, headlights, campfires, or artificial lighting on human structures can cause females to abort nesting attempts and interfere with sea-finding behavior by hatchlings. Beach driving, pedestrian traffic, and beach cleaning poses a risk of injury to nesting females and live stranded turtles and can leave ruts that trap hatchlings attempting to reach the ocean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991). Driving directly above incubating egg clutches can cause sand compaction, which may decrease hatching and emergence success and directly kill pre-emergent hatchlings (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a).

The Refuge has implemented numerous management actions to protect nesting sea turtles and hatchlings: 1) Closing the Hook beach March 15-September 1 Hook to pedestrians and ORVs; 2) Monitoring beaches for crawls; 3) Protecting nests with predator screens; 4) Reducing mammalian and avian predators; 5) Marking nests with "Area Closed" signs and symbolic fencing to prevent human and vehicular disturbance in areas where beaches are open to the public; 6) Erecting light barriers and using "turtle sitters" if hatch window occurs during the time period that ORVs are allowed on the beach. No nests or hatchlings have been knowingly lost to human causes; however, with such a low sample size (few nests laid and most nests lost to storms before the beach being open to ORVs) protective measure #6 has not been thoroughly tested. The one attempt to erect a light barrier composed of silt fence between the ocean and a turtle nest on the Hook resulted in the silt fence being washed out numerous times by high tides and moderate storms (Buffa, pers. obs.).

The most recent Biological Opinion (USFWS 2008c) determined that an incidental take of up to three sea turtle nests over a 5-year period, and no more than one per year, would not jeopardize the loggerhead sea turtle population. Management activities have kept mortality far below this so far. However, if turtle nesting increases on the Refuge there may be more overlap between human disturbance factors and turtle nesting. Sea turtle nests hatch from August through October, and ORV and pedestrian use occurs on the Hook beginning September 1. Furthermore, ORV and pedestrian use can occur on the Overwash for portions of the loggerhead breeding, or the entire breeding season if there are no shorebird chicks. Alternative strategies to protect nests and hatchlings will therefore be developed in the next Chapter.

Objective 1.4 Beach Habitat for Seabeach Amaranth (*Amaranthus pumilus*)

Maintain and expand sandy beach and washover habitat for Seabeach Amaranth along Assateague shoreline by allowing natural process to occur with a goal of increasing the number of plants, as averaged over a 5-year period. By 2015, investigate whether it is feasible and desirable to increase the number of sites occupied by seabeach amaranth from one to two sites by active management such as propagation/ transplanting, re-seeding, or removing artificial dunes that prevent suitable habitat from forming at the north end of Assateague.

Rationale: Historically, seabeach amaranth was native to Atlantic coast barrier island beaches from Massachusetts to South Carolina (USFWS 2008c). This annual plant needs extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner, allowing it to move around the landscape (Weakley et al. 1996). It often grows in the same areas selected by nesting birds such as plovers, terns, and skimmers.

Seabeach amaranth generally occurs in a sparse to very sparse distribution. A typical density is 100 plants per linear km of beach (Weakley et al. 1996). Current density of our one existing population at the north end of Wild Beach is much lower than this - less than 10 plants per km. However, we could find no recent literature or technical expertise on which to formulate a more quantifiable objective.

The recovery objective for seabeach amaranth is to have 75% of the sites with suitable habitat occupied for 10 consecutive years (USFWS 1996). Suitable habitat is defined as overwash flats at accreting spits or ends of barrier islands and the lower foredunes and upper strands of non-eroding beaches. Islands with suitable habitat longer than 5 km have the potential for supporting 2-3 sites (Weakley et al. 1996). Establishing a population on the Hook, where one plant was found on a 2004 survey, would therefore help achieve seabeach amaranth recovery goals (USFWS 1996).

Transplanting and seeding programs have taken place in Delaware, Maryland, North and South Carolina with mixed results. Numbers of seabeach amaranth on the Maryland side of Assateague Island increased exponentially after a transplanting (2000) and exclosure (later years) program was initiated. The reappearance of the plant on the Virginia side of Assateague in 2001 is attributed, at least in part, to these NPS management actions. The success of AINS amaranth management needs to be evaluated along with the pitfalls of other states' efforts in order to implement the most effective methods.

Threats include beach stabilization efforts, intensive recreational use, and herbivory (Weakley et al. 1996). Even "soft" stabilization methods such as placement of sand fences and planting vegetation like beach-grass can be detrimental. Seabeach amaranth rarely persists where vegetative stabilization efforts have taken place (Weakley et al. 1996). Allowing a previously stabilized foredune system to return to more natural conditions may create more favorable habitat conditions for the re-establishment of seabeach amaranth (USFWS 2008c). Sika elk, white-tailed deer, cottontail, migratory songbirds, and feral horses are documented herbivores of amaranth. The non-native, invasive plant Asiatic sand sedge (*Carex kobomugi*) is a potential threat because of its strongly rhizomatous and dune-forming characteristics. (USFWS 1996)

In the geologic past, seabeach amaranth has persisted through even relatively rapid episodes of sea level rise and barrier island retreat. A natural barrier island landscape, even a retreating one, contains localized accreting areas, especially in the vicinity of inlets (USFWS 1996).

Objective 1.5 Salt Marsh Habitats for Nesting, Migrating, and Wintering Birds

Maintain 2,875 acres of salt marsh in Assateague, Morris Island, and Wildcat Marsh Units, and 195 acres on Wallops Island NWR to ensure the quality and natural function of the marsh are sustained and provide breeding, wintering, foraging, and migrating habitat for nesting species such as clapper rail, saltmarsh sparrow and American oystercatcher, wintering species such as American black duck, and migrating shorebirds. This habitat will include a mix of high and low salt marsh vegetation, pool, mudflat, and panne habitat containing less than 5% overall cover of non-native invasive plants. Where this habitat type is degraded by non-native ponies, sika elk, or other factors, enhance its ecological integrity using salt marsh restoration techniques by 2020.

Rationale: Sea-level rise is considered a major threat to bird species in the Virginia Barrier Island/ Lagoon Important Bird Area (IBA) (Watts 2006). Biologists at the Patuxent Wildlife Research Center suggest that submergence of lagoonal marshes in Virginia would have a major negative impact on marsh-nesting birds including clapper rails, black rails, saltmarsh sparrows, seaside sparrows, and American oystercatchers (Erwin et al. 2004).

The clapper rail, a high conservation priority species in BCR 30, is still relatively common in the Chincoteague Bay area. There is still a liberal hunting bag limit on this bird, which is hunted during the fall high tides. Clapper rail use low and high marsh zones, reaching their highest densities in lower parts of the marsh (VDGIF ____).

Whimbrel, a species of highest conservation priority in BCR 30, was selected as a focal species to represent the guild of shorebirds that feed in mudflats at low tide and roost in salt marsh vegetation at high tide. It is a wintering and migrant bird in this area, as are many of the shorebirds that use salt marsh habitats (Table 3.1 and Appendix 1), which include mudflats and salt pannes. The North American whimbrel population is estimated at 66,000 total birds (Morrison et al. 2006), and the Eastern Shore of Virginia is an important spring staging area for whimbrels stopping on their way from wintering areas further south to western and Hudson Bay breeding areas (Watts and Truitt in press). An estimated 80 percent of this population migrates through the Eastern Shore of Virginia (Barry Truitt, TNC, pers. comm.).

The saltmarsh sparrow, a species of highest conservation priority in BCR 30, was selected as a focal species because it is an indicator of healthy salt marsh habitat. Saltmarsh sparrows breed in large patches, ≥ 50 hectares in size, of high marsh dominated by *Spartina patens*; they forage in low marsh dominated by *S. alterniflora* and *Distichlis spicata* (Fletcher Smith, Ctr. Conser. Biol, pers. comm.). Chincoteague NWR is unique in being one of the few places that have good numbers of breeding and wintering saltmarsh sparrows; estimated at 2.47 birds per hectare and 2.3 birds per hectare, respectively (CCB unpubl. data and Paxton 2007). Twice the number of wintering birds was detected on or near CNWR during winter 2009-10 surveys conducted throughout Virginia, compared with any other of the 28 study sites (Smith, pers. comm.). Saltmarsh sparrows reach their southern breeding limit at the south end of Accomack Co. and the species has a small total population size, estimated at 35,000 individuals (Smith, pers. comm.).

American oystercatcher were selected as a focal species because they are a species of conservation concern in Virginia and use a range of salt marsh habitats for their life history needs. They nest on low salt marsh islands and their shelly perimeters (Rounds et. al 2004). During the non-breeding season they gather in communal high-tide roosting flocks on sand or mud flats, oyster shell rakes, and topographic high spots in the marsh (Wilke et al. 2007). Together, Maryland and Virginia support 27% of the estimated number of American oystercatcher breeding pairs on the east coast of the U.S., and 90% of breeding pairs in Virginia nest on seaside bays and barrier islands (Wilke et al. 2007).

The American black duck is a globally vulnerable watch list species, considered one of the highest priority species of concern by the Atlantic Coast and Eastern Habitat Joint Ventures (Steinkamp 2008); its continental population is half of its historic size (Longcore et al. 2000). Since 2001, the Mid-Atlantic region (including New Jersey, Delaware, and Virginia) has accounted for approximately 68% of the U.S. wintering population (____2009). Within the Mid-Atlantic region, Virginia comprises about 12% of the wintering population (VDGIF 2005).

Figure 7 Abundance of wintering black duck and mallard counted in Stratum VA3-16 (Refuge impoundments and adjacent salt marsh) during USFWS' mid-winter waterfowl survey (MWI) (Devers 2009)

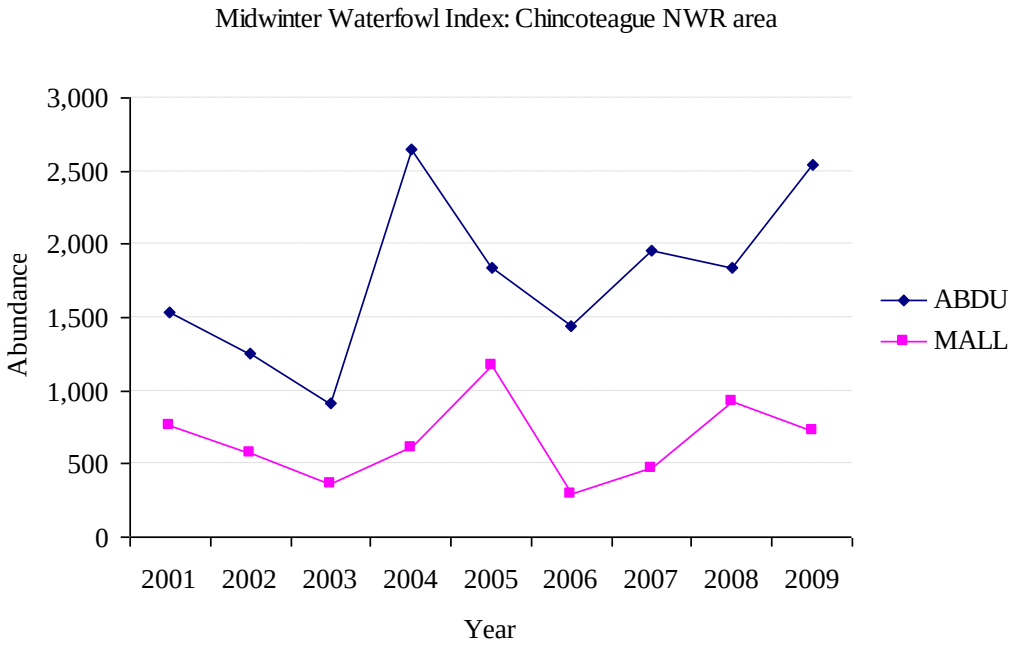
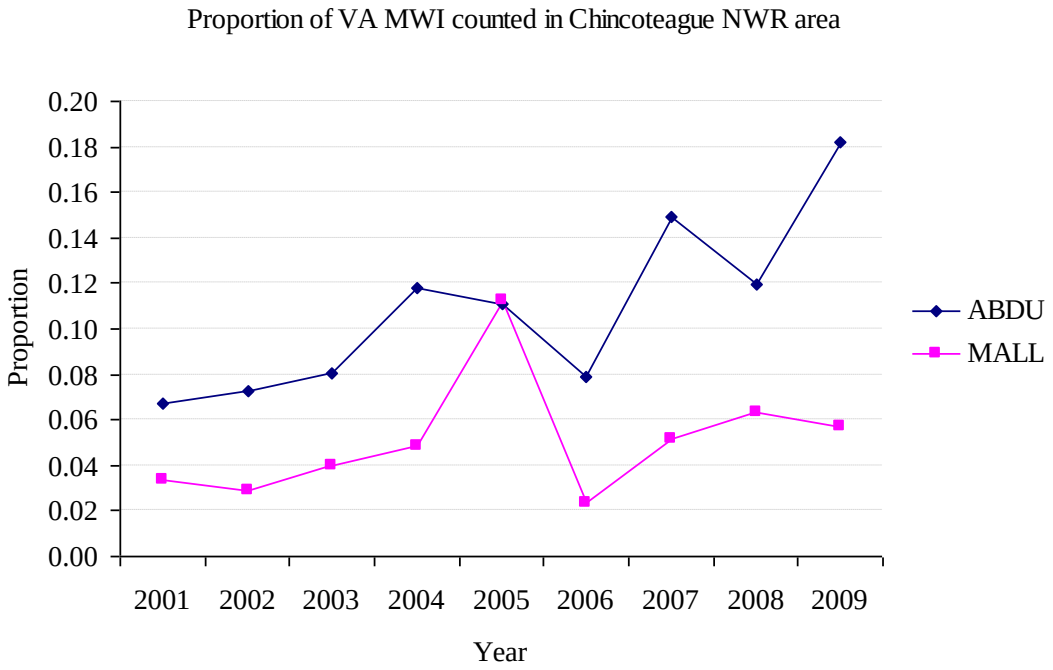


Figure 8 Proportion of Virginia's wintering black ducks and mallards counted in Stratum VA3-16 during USFWS' annual mid-winter waterfowl survey (Devers 2009).



One long-term measure of black duck winter population trend is USFWS' mid-winter aerial waterfowl survey, conducted by the VDGIF during the first week of January. Stratum VA3-16 covers all of Assateague Island's impoundments and salt marshes between Wallops Island and the Maryland/Virginia line. Between 2001 and 2009, there has been an increasing trend in the number of black ducks counted in StratumVA3-16 during the annual mid-winter inventory (Figure 7). Perhaps more importantly, the proportion of wintering black ducks in Virginia that are counted in Stratum VA3-16 (Figure 8) has been steadily increasing. These data suggest that impoundments and salt marshes on Assateague, Wildcat Marsh, and Morris Islands, and surrounding tidal marshes in Chincoteague Bay and Assateague Channel, provide important wintering habitat for black ducks. (This paragraph is based on Devers 2009.)

Black ducks use a wide variety of wetland and upland associations to meet their habitat needs (Longcore et al. 2000). Typically, black ducks will feed in salt marsh and mudflats throughout the day depending on the tide. They will use freshwater ponds for loafing and feeding. The presence of mallards is also a very important consideration when managing habitats to benefit black ducks because most freshwater habitat management that benefits black ducks will also benefit mallards. In fact, it may be more important to emphasize management activities which will not encourage or benefit mallards rather than solely on how to manage for black ducks because ducks pair on the wintering grounds and black duck/mallard hybridization is a conservation concern. For example, managing freshwater impoundments for food production and loafing sites will benefit black ducks, but it will also benefit mallards. In contrast, salt marsh provides important foraging habitat for black ducks, can provide hiding and loafing areas, and most importantly, mallards make much less use of salt marsh than do black ducks. (Except where otherwise cited, entire paragraph based on Devers 2009)

With the exception of pony grazing on certain areas of Assateague Island, the salt marshes on Chincoteague NWR are relatively unaltered. Grazing effects on wildlife are mixed. Grazing can help attain wildlife objectives. For example, allowing ponies in North Wash Flats impoundment prior to the breeding season removes vegetation, creating preferred habitat for plovers and other "beach nesting" birds. Pony fecal matter may stimulate the growth of invertebrate food matter for waterfowl. In salt marshes, the impacts of pony grazing on wildlife habitat may outweigh the benefits because: 1) Trampling during the nesting season can disturb or destroy nests; 2) Direct forage competition reduces food resources for wildlife; and 3) Grazing alters vegetation structure and species composition resulting in habitat loss for marsh-dependent focal species.

Studies of pony grazing on vegetation communities on the Maryland end of Assateague Island by the NPS (Sturm 2007 and 2008) are applicable to the Refuge because herd size (150) and vegetation types are comparable to the Virginia side. Comparing grazed to un-grazed low salt marsh study sites, Sturm 2008 found that areas grazed by ponies had significantly lower overall plant cover, decreased reproductive success of *Spartina alterniflora*, and a shift in species composition from *S. alterniflora* to *Distichlis spicata*. Ponies alter the species composition of low salt marsh communities by preferentially grazing on *S. alterniflora*, thus providing a competitive advantage to other plant species. The latter is significant for wildlife because *D. spicata* (saltgrass) provides very poor nesting cover and food resources for focal species compared to *S. alterniflora* (Sturm 2007 and 2008). Pony grazing is therefore a concern in salt marshes because it can reduce the abundance and distributions of salt marsh obligate breeding birds such as clapper rail, seaside, and saltmarsh sparrows (NPS 2006).

Recent research by the NPS also found evidence that ponies' grazing stimulates the accelerated expansion of *Phragmites australis*, an aggressive invasive species (Mark Sturm, AINS, pers. comm.). This would further adversely impact wildlife habitat because *Phragmites* displaces plant species favored by focal species for nesting and feeding.

The Refuge's tidal marshes are important nursery areas for common mummichogs, Atlantic silverside, and American eel, and are important for other resident and transient fish and shellfish species that move in and out of marshes to take advantage of the abundance of prey items (Mangold and Eyler 2006). Here the pressure from predators is lower and these fish can tolerate the low oxygen, higher water temperatures, and high salinity. These small fish species are prey for foraging birds such as herons, egrets, and glossy ibis. In the fall, the fish migrate out to the estuary, where they are prey for birds as well as commercial and sport fish (Mangold and Eyler 2006).

Objective 1.6 Sea-level Fen on Wallops Island NWR

Over the 15-year life of the HMP, protect the integrity of Lucky Boy Fen by maintaining and enforcing the public closure around the perimeter of the quarter-acre area, protecting the freshwater recharge, maintaining forest cover upslope, and ensuring that invasive non-native vegetation does not exceed a threshold of 5% cover.

Rationale: According to VDCR (2001) and Accomack Co. (2008), a fen is a unique and extremely rare type of freshwater wetland located at the upland edge of a wide, ocean-side tidal marsh. A fen is distinguished from a marsh or a bog by unique hydrological regimes and vegetation that is an unusual combination of northern bog plants and southern tidal freshwater wetlands plants. Sea level fens were first discovered in 1991. Superior examples of this community type have been found in only five locations on the East Coast, and cover a total of no more than ten acres. They have thus far only been documented in Accomack County, Virginia and Sussex County, Delaware.

The number of rare species documented in Lucky Boy Fen is high in proportion to its size, mapped in the field using a hand-held Garmin GPS at 0.18 acres in November 2009. It contains two plant species (brown-fruited rush and few-flowered beakrush) considered "critically imperiled" and four plant species (southern bladderwort, ten-angle pipewort, white beakrush, and white-topped fleabane) considered "imperiled" in the state by VDCR's Natural Heritage Division. For some of plant species, Virginia's sea-level fens represent the southernmost extent of their range and the only habitat that supports these species in the state.

The greatest threat to sea-level fens in general is groundwater pollution. Possible movement of fertilizers and wastes into the groundwater from nearby developments or agricultural fields can lead to increased nutrient levels in the fen. Increased nutrient levels can disrupt soil characteristics and affect the plant species that naturally exist in fen conditions. Nearby developed areas include Highway 175 and the NASA Wallops Flight Facility, both within ½ mile of Lucky Boy Fen. Agricultural fields are not close enough to pose a concern.

Other potential threats to the Lucky Boy Fen include encroachment of invasive species and trampling by grazing animals or visitors (Buffa, pers. obs). Establishment of a deer hunt decreased the likelihood of over-grazing or trampling by deer, and the fen is off-limits to hunters. The fen is located in a remote part of the Refuge, far from any trails or footpaths, making trampling by visitors during the non-hunting season unlikely. "Closed Area" signs have been placed around the perimeter.

Objective 1.7 Tidal Creeks, Estuaries, Mudflats, and Nearshore Marine Waters

Protect the ecological integrity of these habitats through an active role in local, state, and federal partnerships, and make sure that USFWS trust species' needs are addressed in decisions and actions affecting areas within the focus areas of Chincoteague and Wallops Island NWRs.

Rationale: Most "Refuge" species depend on off-Refuge habitats to fulfill one or more of their life cycle needs. Pollutants, human disturbance, or other activities off-Refuge can influence the success of management activities that the Refuge undertakes. For example, off-shore oil drilling and development of wind turbines on or off-coast are potential activities that could impact migratory birds and bats. The scarcity of resources among partners makes pooling of funds and staff even more important.

4.2 Goal 2. Managed Wetlands (Impoundments)

Manage Refuge impoundments to support native wildlife and plant communities, including a diversity of waterbirds, other aquatic species, and species of conservation concern. When an impoundment no longer

meets conservation targets or is not viable to maintain due to sea level rise, restore its natural hydrology and manage it as part of the natural system.

Objective 2.1 Impoundments for migrating/wintering/breeding waterfowl, shorebirds, waders

Provide approximately 2,650 acres of quality wetland habitat to support wintering waterfowl, spring migrating shorebirds, breeding shorebirds and waterbirds, and fall migrating shorebirds and waterfowl until Structured Decision Making (SDM) restoration criteria are met. A Water Management Plan detailing management prescriptions to achieve objectives listed below will be prepared annually. Refuge staff will continue to monitor and assess each impoundment using use the Coastal Impoundment SDM model to evaluate whether to continue managing it for current capabilities (see Table 5.1), or to restore it to a natural, unmanaged hydrology. Taxa-specific objectives may be rotated among impoundments from year to year depending on environmental conditions and impoundment capabilities, and will be directed to provide the following:

(1) Manage 55-75% of the impoundments' surface area each winter (December through mid-March) to provide shallow flooded (<12" water depth) and seed-producing moist-soil vegetation for wintering waterfowl including black duck, pintail, gadwall, shoveler, teal, and snow geese.

(2) Manage 35-50% of the impoundments' surface area each spring (April-May), and 25-40% each early fall (July-October) to provide a mix of 40% mudflat and shallow water (<4" water depth) with sparse vegetation (<15% cover) for migrating shorebirds (e.g., short-billed dowitcher, dunlin, semipalmated sandpiper, yellowlegs).

(3) Manage 40-50% of the impoundments' surface area each fall (late October through November) for migrating waterfowl (e.g., black duck, green-winged teal, blue-winged teal) to provide shallow flooded (<12" water depth) annual vegetation composed primarily of *Scirpus, Echinochloa, Polygonum, Bidens* and other seed producing moist soil vegetation at time of peak migration and by controlling invasive species.

(4) Manage North Wash Flats impoundment to provide 90% dry habitat conditions for breeding piping plover, Wilson's plover and least terns between March 15 and September 1, or until all chicks are fledged.

(5) Provide concentrated food resources in at least 2 impoundments during June-August each year for breeding waterbirds such as snowy egrets, glossy ibis, and herons by drawing down water levels.

Rationale: All of the impoundments, with one exception, were constructed in the 1950s and 1960s with the primary purpose of providing waterfowl migration and wintering habitat; Farm Fields was constructed in 1992. The management objectives of the impoundments have broadened over time and considerable resources have been invested in managing them through actions such as flooding, drawdown, disking, hydro-axing, mowing, seeding, planting, burning, and control of non-native *Phragmites*. In 2009 nearly 140 acres of this invasive plant was mapped in and adjacent to Refuge impoundments, and aggressive herbicide treatments over the last several years are keeping *Phragmites* in check.

Impoundments supply numerous habitat benefits for a variety of taxa including waterfowl wintering/ migratory habitat; food sources for waterbirds of conservation concern such as snowy egret, glossy ibis, Forster's and gull-billed terns; and shorebird migratory stopover habitat for many species of conservation concern including short-billed dowitcher, dunlin, and semipalmated sandpiper. North Wash Flats impoundment is managed as piping plover nesting habitat during the breeding season to mitigate for beach habitat impacted by the public beach and parking lots (USFWS 2008c), but flooded in winter for waterfowl. Impoundment vegetation such as *Bidens* provides nectar sources for fall migrating monarch butterflies. Fall migrating landbirds feed and rest in shrubby edges rimming the impoundments that are maintained in early successional stages by impoundment management activities. Impoundments concentrate large flocks of birds, providing wildlife viewing, photography, education, and interpretation

opportunities – four of the "big six" wildlife dependent recreational activities. Furthermore, impoundment levees and dikes are used as walking and biking trails, and the wildlife driving loop in on top of an impoundment dike.

All impoundments depend entirely on precipitation for their source of freshwater, and gravity or evaporation for drawdown. Both limit management capabilities. Tidal cycles and storm events, especially nor'easters and hurricanes, further challenge the attainment of management goals for impoundments. For example, impoundments won't drain when the tide on the outboard side of the water control structure is too high, and storm events can overtop dikes increasing salinity as well as water levels. As sea level continues to rise, damage to dikes and other impoundment infrastructure can be expected. Maintaining water depths at desirable levels may also become more difficult. At some point, the cost of maintaining a particular impoundment may exceed the benefits.

Objective 2.2 Impoundment Management for American Black Duck

By 2014, enhance or restore 100 acres of impoundments to meet the habitat needs of black ducks by conducting a habitat analysis to determine which impoundments best meet their feeding, loafing, and thermal requirements, and which impoundment (s) could be enhanced; plan/implement habitat restoration/enhancement on 1-2 impoundments using an Adaptive Management approach.

Rationale: The American black duck is a species which has declined by as much as 60% on their wintering grounds (Eichholz and Yerkes 2009). Decline of wintering habitat quantity or quality is one factor likely responsible for the observed decline in black duck populations. Invertebrates comprise the majority of black duck diet, and in Virginia wintering areas, mudflat and salt marsh provide the greatest invertebrate biomass (Eichholz and Yerkes 2009). While Refuge impoundments supply important undisturbed (from hunting) loafing habitat, some impoundments receive little use by black ducks (Refuge unpubl. waterfowl census data). Lighthouse Pool's dike is already breached and *Phragmites* infestation further diminishes habitat quality. Introducing tidal action could restore native salt marsh plants.

Impoundments with low current bird use and a direct connection to Chincoteague Bay by water control structure (WCS), such as Sow Pond and Ragged Point Pond, have the highest priority for restoration to tidal salt marsh, which could provide higher value feeding areas (Devers 2009). F-Pool also is a good candidate for restoration because it is extremely vulnerable to sea level rise and failure of WCS and other infrastructure. Flooding of F-Pool by ocean waves and rain during a November 2009 nor'easter undermined a portion of Beach Road, and eroded banks around the WCS. Restoration must be carefully considered however since F-Pool receives high use by waterfowl and shorebirds (Refuge unpubl. data).

The benefits of maintaining a particular impoundment also need to be weighed against the benefits of restoring natural hydrology. Refuge impoundments provide important daytime loafing areas adjacent to salt marshes, where black ducks feed at night (Devers 2009). If the habitat analysis shows loafing or thermal cover to be limiting, this habitat type for black ducks could be enhanced by allowing myrtle bushes to encroach and be flooded in some areas.

Black ducks likely spend more time during the day loafing on wetlands closed to hunting, such as Refuge impoundments, because they are very sensitive to human disturbance (Devers 2009). Belanger and Lehoux (1994) found that black duck use was significantly greater in non-hunted freshwater impoundments than hunted salt marsh and brackish impoundments, but observed this difference only during the hunting season. Restoring Sow Pond or Ragged Point impoundments (which currently have low waterfowl/shorebird use) to tidal marsh could increase important food resources for black ducks with few impacts to other species.

Coastal refuges in Region 5 are currently developing a tool, or model, that can be used to weigh the costs and benefits of maintaining an impoundment, and reach a decision about whether to restore or maintain it. Since this model will be science-based, have technical expert review, evaluate CNWR's impoundment habitat in a regional context, and be consistent with other coastal refuges, Refuge staff plans to use the

Coastal Impoundment SDM model to direct future management for each of its impoundments. Through this adaptive management approach, we will continuously assess the feasibility of maintaining an impoundment by evaluating its ability to meet conservation targets in light of sea level rise and other factors. While the starting point is managing 2,650 acres of impoundments, we anticipate that some impoundments will be restored within the 15-years life-span of this HMP (see Objective 2.2).

Objective 2.3 Impoundment Management for Monarch Butterflies (See also Objective 3.2)

Manage at least 40 acres in the Impoundments Unit (bottoms of impoundments) each fall, through water-level manipulation and mechanical treatment, with the goal of providing 50% cover of *Bidens laevis* **(**or other favored nectaring plants) on these 40 acres during peak monarch migration (mid-September through mid-October). Defer mowing of any *Bidens* flowering on dike edges until after November 1 or seed set.

Rationale: *Bidens* is a prime peak migration nectar source for monarchs, as well as an excellent seed source for waterfowl (Gibbs 2008). This species grows in the borrow ditches of impoundments, especially those along the Wildlife Loop, and can cover large portions of some impoundments, including B-North, C- Pool, D-Pool, and E-Pool (Figure 12). It often blooms in mass, particularly in years where there is a wet spring (Eva Savage, CNWR Bio Tech, pers. comm.). Blooming times vary from mid-September to mid-October, depending on rainfall from late summer storms and fall hurricanes; plants often hold buds closed for weeks until there is sufficient rainfall (Gibbs 2008). *Bidens* is particularly attractive to migrating monarchs because it often covers large areas and provides a quality nectar source.

Periodic mowing and disking seems to enhance the germination and growth of *Bidens* in Refuge impoundments (Eva Savage, CNWR Bio Tech, pers. comm.). Fall is sometimes the only time that mowing can be accomplished due to breeding birds or wet conditions during other times of the year. Therefore, fall mowing will be strategically planned so that at least half of the identified nectar sources will be left un-mowed for butterflies (Figure 9). Timing and amount of precipitation also seems to affect *Bidens*; in drought years there are very few blooms and in wet years the bloom occurs in mid to late-September (Gibbs 2008). Because germination requirements for *Bidens* are incompletely understood and this plant provides such an important nectar source, Ms. Gibbs has volunteered to do greenhouse propagation experiments using seeds collected on the Refuge.

Objective 2.4 Artificial Nesting Structures

Annually maintain 35 nest boxes located in or adjacent to impoundments for tree swallows. Discontinue maintaining wood duck nest boxes.

Rationale: Providing tree swallow nesting boxes is perhaps the longest-running wildlife management practice on the Refuge. Chincoteague's first Refuge Manager, John Buckalew, first installed the boxes during his tenure, and maintained them throughout his retirement (Paul Smith, pers. comm.). After John's death, the boxes were not monitored or maintained and fell into disrepair until Refuge Volunteer Paul Smith revived them as an Elderhostel project. In 2005, 35 new boxes were placed in identical or slightly different locations in more suitable habitat, if conditions had changed. Each October, Road Scholar (formerly Service Elderhostel) volunteers check the boxes for nesting activity, cleaning and repairing or replacing boxes as necessary. Occupancy is considered high; in the most recent 5 years (2005-2009) 72% to 89% of the boxes had tree swallow nests and 72% to 100% had been used by either a tree swallow or other bird species.

Arguably, the swallow boxes currently serve more of an interpretive function than a conservation need for tree swallows, who are not an HMP focal species nor a bird of conservation concern. On the other hand, having a nesting species associated with impoundments that is easily accessible for study may be important in planning future impoundment restoration projects. Sediment contamination is often a potential issue in tidal marsh restoration. Tree swallows are a useful bird species to measure exposure and effects of environmental contaminants because they are widely distributed throughout the United States, and feed near their nest box on emergent aquatic insects (USGS 2003). Aquatic insects emerge from

sediments, so the swallows' tissues reflect levels of contaminants in sediments (USGS 2003). Maintaining the swallow boxes takes virtually no staff time or resources, leave options open for future contaminant studies, provide a way of connecting people with nature, and are a popular volunteer service project.

Wood duck nest boxes were installed on the Refuge's impoundments in 1972, following a release of pen-reared wood ducks. Since waterfowl breeding habitat is no longer emphasized on this Refuge, duck use of the boxes is low (occupancy ranged from 7% to 27% over the past 5 years), and staff time spent on the project (which include training volunteers/interns, purchasing supplies, record-keeping) exceeds the benefits, maintaining the boxes is not justified. Furthermore, wood ducks are increasing overall (Appendix 1), and their main breeding range is further south.

4.3 Goal 3. Upland Habitats

Manage upland habitats to provide forage, cover, and other essential habitat components for landbirds, migrating monarch butterflies, and Delmarva fox squirrel. Ensure that some habitat exists for early successional species such as bobwhite and brown thrasher.

Objective 3.1 Shrub Habitat for Breeding and Migrating Landbirds
Maintain 2,500 acres of coastal shrubland dominated by wax myrtle, bayberry, and groundsel to provide forage and cover habitat for fall landbird migrants, and breeding, and wintering landbirds. One hundred percent of this habitat should be native species, at least 50% of which should be fruit-bearing shrubs averaging 3 meters in height and contain few or no pine trees. Where site conditions allow, maintain and/or restore a continuous band of this habitat, 300 feet or more in width, between impoundments and the dune line.

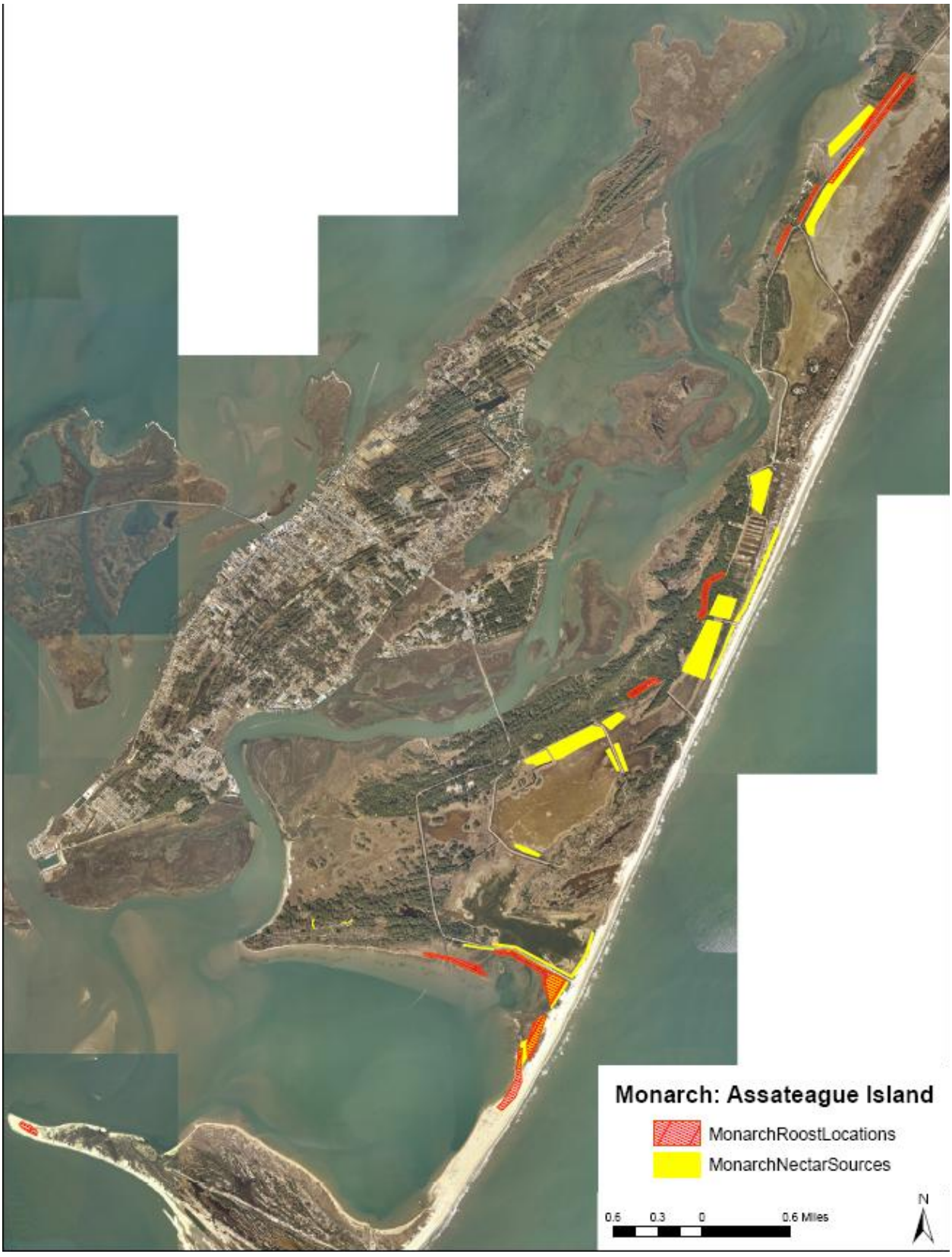
Rationale: Bird species that depend on shrubs and other early-successional habitats are declining in the eastern U.S. due to loss of habitat. Shrubs provide an abundance of insect food for breeding birds, and berries during the fall migration and/or throughout the winter. The large number of yellow-rumped warblers that winter on the Refuge, as well as tree swallows feed on wax myrtle berries. In fact the yellow-rumped warbler was formerly called the myrtle warbler.

Long-term passerine banding stations at Cape May, New Jersey, Kiptopeke State Park at the end of the Delmarva Peninsula, and other studies have established that southbound landbirds migrate close to shore along the Atlantic seaboard, and that the Delmarva Peninsula funnels birds south to the tip of the Peninsula. Migrating birds depend on stopover habitat along migration routes where they can find food, water, and protection to regain energy lost in flight and re-fuel for the next leg of the journey (Duncan et al. 2002). Robert's (2009) 10-year banding study found that the Refuge's wax myrtle/bayberry/groundsel shrub community provides important stopover habitat. Where this community grows parallel to and behind (generally westward of) the primary dune line, it may provide the first suitable habitat encountered by fall migrants that are returning to land after being blown out over the ocean. The majority of fall migrants are hatching year birds, and therefore inexperienced migrants. Finding shelter and food in this narrow line of vegetation may ensure their survival and recruitment into the breeding population the following year. The banding station located in this habitat type between the Toms Cove Visitor Center and the beach had the highest multi-year capture rate observed on the Refuge (Roberts 2009).

Dense, tall (3.0-3.5 meter high) wax myrtle/bayberry habitat between impoundments and the dune line is also preferred nesting habitat for passerines, including several of highest and high conservation concern BCR 30 species such as prairie warbler, field sparrow, and brown thrasher. Recaptures of breeding birds like yellow warbler and common yellowthroat indicate it is high quality breeding habitat (Roberts 2009).

A recent 3-year study at AINS used a series of exclosure treatments to assess the influence of pony herbivory on Assateague Island's shrub and forest habitats. The results indicate that pony grazing is reducing species diversity in forest habitats and altering vegetative community composition in both shrub

Figure 9 Monarch Nectar Source and Roost Locations: Assateague Island (Based on Gibbs 2008)



and forest habitats (Sturm 2007). The study found that pony grazing also influences the abundance and average height of several native plant species in these habitats. Because the ponies an economic resource for the volunteer fire department and town of Chincoteague, and have a large public constituency, it is unlikely that this non-native species will be eliminated from the Refuge. The CCP, however, will evaluate the resource impacts of maintaining the current herd size of 150 adults.

Grazing by sika elk and white-tailed deer is a potential threat to achieving objectives if numbers are not managed by hunting. Due to difficulties in eliminating the non-native sika and a constituency that enjoys the resource, the Refuge maintains sika at a population level low enough to reduce resource damage.

Objective 3.2 Roosting and Nectar Source Habitats for Monarch Butterflies (See also Obj. 2.3)

Maintain, through rotational mowing, a minimum of 80% of the reliable monarch roosting locations and 50% of the preferred nectar source locations in an unaltered state during the migration period (mid-September through mid-October) in any given year (Figure 9). Restore and enhance preferred nectaring plants (seaside goldenrod, *Bidens laevis*) in areas where they already grow or other suitable areas. Roosting habitat is defined as thickets of bayberry, groundsel-tree, black cherry, marsh elder, or red cedar with an eastern exposure of a patch size sufficient to buffer winds adjacent to large open areas such as north side of Toms Cove and western side of impoundments.

Rationale: The migration and wintering biology of the eastern population of the monarch butterfly has been labeled an "endangered biological phenomenon" (Gibbs 2008). The insect makes a journey of up to 2,200 miles, from summer breeding areas in New England and Canada to wintering grounds in Mexico's central mountains, in the state of Michoacán. Assateague Island is a critical stopover point for southbound migrating monarchs that use the Refuge's resources to rest, refuel, and roost for the night. Over 100,000 monarchs have been counted during one day from a fixed count point on the Refuge (Gibbs 2008).

Nectar source plants located in various Refuge habitats including impoundment bottoms and dikes, Beach Road adjacent to Toms Cove, the Overwash, and tip of the Hook, bloom in succession during the migration period. Based on a tagging study, monarchs stay on the Refuge as long as 5 days, nectaring on flowers to build up fat that will sustain them on the next leg of their southbound migration. Stands of seaside goldenrod (*Solidago sempervirens*), the most important nectar source on the Refuge, can be lost or thinned from natural causes (salt-spray, overwash, storms), or management activities (roadside mowing, parking lot maintenance, facilities maintenance). Recent experiments with seed collection and planting seedlings have been successful in re-establishing/enhancing goldenrod stands. Bur-marigold (*Bidens laevis*), another important nectar source on the Refuge, grows in impoundments. It is an annual plant and periodic mowing and water manipulation appears to favor its habitat requirements, so managing for 100% availability of all potential *Bidens laevis* areas is not possible (i.e., some will need to be managed on a rotational basis – see Objectives 2.1 and 2.3). The most important nectar locations used during Gibbs' 1996-2007 study are shown in Figure 9.

Roosting site locations vary somewhat from year to year, but some reliable roosts identified during the Gibbs' 10-year study are shown in Figure 10. They are generally found on the east-facing and/or leeward side of trees and shrub clumps. Species used include wax myrtle, bayberry, groundsel, cherry, marsh elder, and eastern red cedar.

Southbound monarchs migrate close to shore, seeking protection from the wind behind low growing plants, manmade objects such as fences, and even tire tracks in the sand. On very windy days they wait for the wind to dissipate before crossing Chincoteague Bay. Management activities to return the beach to more natural processes, no longer maintaining the artificial dune around the public beach and removing the split rail fences around the parking areas, removed some monarch wind breaks. Without daytime roosting areas that are protected from the wind on large open areas such as the Hook and Overwash, monarchs may deplete energy reserves to the point they are unable to continue southward migration, or are blown out to sea. Providing small, temporary, low-profile wind buffers and/or planting nectar sources in critical areas would mitigate this threat (Gibbs 2008).

Objective 3.3 Roadsides and Dikes for Squirrels, Monarchs and Ground Nesting Birds

Manage mowing on Refuge roadsides, cross-dikes and fence lines in order to minimize Delmarva fox squirrel vehicle mortality at 5 or fewer squirrels per year, and maximize nesting opportunities for northern bobwhite and brown thrasher. Height of roadside vegetation along Beach Road west of the Pony Coral will be maintained at ≤ 6 inches. Mowing of other roads, trails, dikes will be confined to the non-growing season: November 1 – April 1, except where there are over-riding needs to protect public safety or wildlife species.

Rationale: The Delmarva fox squirrel (DFS) was selected as a focal species because of its endangered status and the importance of Chincoteague to species recovery. The Chincoteague population is one of 15 large to very large sub-populations identified as likely or very likely to persist (USFWS 2007). Chincoteague was one of seven benchmark sites for monitoring population dynamics, identified in the 1993 DFS recovery plan (USFWS 2007).

Collisions with vehicles on Beach Road killed an average of 5 DFS per year in the 8-year period between 2003 and 2010 (unpubl. Refuge data). DFS spend more time on the ground foraging than other squirrel species, and are often seen feeding on ground fungi and other plant materials on the edges of Beach Road (Buffa, pers. obs.). Beach Road traverses several DFS management areas with high population densities: Lighthouse Ridge, White Hills, and Woodland Trail. Refuge biology staff noted that when grass along Beach Road reached a height that could conceal squirrels, the number of DFS killed by vehicles increased, so it became a standard operating procedure to regularly mow the entrance road (Eva Savage, CNWR Bio Tech, pers. comm.).

Northern bobwhite and brown thrasher were selected as focal species because, compared to other Northeast Region Refuges with Breeding Bird Survey (BBS) routes, Chincoteague ranked third in the number of northern bobwhite and brown thrasher detected between 1996 and 2001 on BBS routes (Appendix 4). Bobwhite, and many other birds that nest in grasslands and shrubs, have declined throughout their range, primarily because early successional and edge habitats have declined in the eastern United States (Steinkamp 2008). Populations of brown thrashers declined significantly rangewide at a rate of 1.2% per year based on Breeding Bird Survey data from 1969 to 1996, and at a rate of 2.2% per year based on Christmas Bird Count data from 1959 to 1988 (Cavitt and Haas 2000).

The preferred habitat of bobwhites is a mixture of grassland, brushy areas and woodland interspersed to provide abundant areas of edge habitat (Quail Unlimited____a). Nests are built on ground, usually within 50-60 feet (15–20 m) of openings such as fields, disked strips, or roads; nests are almost always found on areas partially covered with standing vegetation <18 inches (45 cm) tall (Brennan 1999). Bobwhites nest from April to September. Brood-rearing habitat (June-October) requires overhead cover to protect chicks from predators and weather (Quail Unlimited ___a).

Most grass and shrub habitats on the Refuge are maintained by disturbance, however mowing during bird nesting and brood-rearing periods can cause mortality. Mowing along some roads and trails is also done for human safety and comfort, and to maintain the integrity of the road and trail surface. For example, wooden roadside barrier posts that become hidden in tall grass pose a hazard to motorists, cyclists, and pedestrians. Mowing the road edge of the Wildlife Loop allows visitors to exit cars, and pedestrians and bikers to stand at the edge of the road to view wildlife without having to worry about disease-carrying insects and arachnids. Mowing of dikes is needed to prevent woody encroachment and maintain impoundments in an early stage of succession.

Objective 3.4 Forested Uplands for DFS, Brown-headed Nuthatch and Eastern Towhee

Diversify the structure and age-class of 1,600 acres of predominantly mature loblolly pine forest on Assateague Island to create habitat conditions favorable to support a minimum population of 200 Delmarva fox squirrels, and breeding habitat for brown-headed nuthatch and eastern towhee. Manage natural disease outbreaks to create younger class stands that vary in size between two and ten acres, and

Figure 10 Maritime Forest: Assateague Island

favor regeneration of hardwoods. Within three years of plan implementation, thin 50 acres of young, overstocked, monotypic stands of loblolly that have no shrub or hardwood understory. Also during the first five years of plan implementation, develop silvicultural prescriptions to create small openings in the forest that will increase the hardwood component.

Rationale: Forest habitat on Assateague Island consists largely of monotypic stands of even-aged, mature loblolly pine trees, aged 65 years or older; some older than 100 years (Paul Merten, USDA Entomologist, pers. comm.). Without management, these mature age classes are vulnerable to catastrophic loss from insect damage, stand replacing fire, or extreme weather/wind events. The southern pine beetle (*Dendroctonus frontalis*), a native species, is the only major known insect threat to this forest. Some younger forest stands date back to pine beetle (SPB) infestations in 1983 and 1994 when blocks of forest were clear-cut in Black Duck Drain (1983) and Woodland Trail/Wildlife Loop /White Hills (1994) to control the outbreak. Many of these younger stands are dense and stunted, with understory habitat conditions unfavorable for focal species. The objective to create a mosaic of pine and hardwood trees of varying age classes and structural diversity would make the forest more resistant to SPB outbreaks, and create habitat characteristics more favorable to the DFS, bobwhite, brown-headed nuthatch, and eastern towhee. SPB does not attack hardwood trees and younger age-class trees provide a barrier to bark beetle spread (Merten, pers. comm.).

The 1992 Upland Management Plan (CNWR 1992) described three forest habitat types (See Appendix10 for description of Timber Compartments):

1) Pure Pine: Nearly monotypic stands of even-aged loblolly pine comprise an estimated 55% (825 acres) of the forested uplands on Assateague, divided into six compartments: Lighthouse, Wildlife Loop, Wash Flats, Sow Pond, Ragged Point and Great Neck (at north end near Old Fields impoundment). The understory is often a tangle of various brush and vine species including high bush blueberry, wax myrtle, greenbrier, and poison ivy. Most of these stands are incapable of developing a hardwood component due to soil type, proximity to salt spray, lack of seed source, or climatic restrictions. Many of these stands are considered over-stocked and/or over mature. This crowded situation has caused growth to cease in many stands. Age, poor site quality, and low tree vigor have made these stands vulnerable to attack by SPB. DFS occur in this forest habitat type, so management of these stands for a more varied age classes would reduce the SPB hazard and benefit DFS.

2) Loblolly Pine/Mixed Hardwood: This forest type comprises an estimated 20% (300 acres) of the forest on Assateague, located in three compartments: White Hills, Woodland Trail, and Lighthouse. It is made up of 25% to 70% loblolly pine stems, and hardwood species such as southern red oak, water oak, red maple, American holly, black cherry, sweet gum, and persimmon. Since loblolly pine are only moderately tolerant of shade and suffer from hardwood root competition, this habitat type will eventually include even more hardwoods as ecological succession progresses. Only major ecological disturbances such as logging, prescribed or wild fire, salt water flooding, or wind throw returns these sites to pure pine stands.

3) Early Successional Pine**:** This forest type comprised an estimated 25% (375 acres) of the forest in 1992 (CNWR 1992). However, a more recent inventory has not been completed and succession and additional cutting for SPB control in 1994 and 2009 undoubtedly affected the amount of acres of early successional pine habitat. In 1992, this forest type was located in three compartments: White Hills, Woodland Trail, and Lighthouse. Species composition is similar to #2 described above; however, these stands are in earlier stages of ecological succession. The loblolly pines are more abundant and largely dominant and the hardwood species present are fewer, sparsely distributed, and are understory trees or saplings. The overstory pines will serve as nurse trees, sheltering the developing hardwood component. The hardwoods will increase as the stand proceeds to develop into the desired loblolly/mixed hardwood type. These areas may lose their pines to SPB attack. An acceptable event in that this will allow hardwood succession

to proceed or may reset pine succession to an earlier stage. Heavy site preparation or repeated hot prescribed burns will also set back pine succession to earlier stage.

The natural fire frequency for southern pine forests of the Mid-Atlantic is estimated at 5-15 years (Kulynycz 2004 and Tim Craig, USFWS Fire Mgmt Officer, pers. comm.). Reintroducing fire into the "pure pine" habitat type described above through prescribed burning could create open understory habitat conditions preferred by DFS (USFWS 2003 and 2007), diversify the age-class and structure of the forest, and mimic natural disturbance factors. Although Kulynycz 2004 found no significant difference in DFS use between burned and un-burned sites, she cautioned against interpreting these results as being a recommendation against prescribed burning. An incomplete burn and pre-burn habitat use by DFS may have confounded results. Late spring or early summer prescribed burning of loblolly pine on Assateague Island in three year intervals was recommended (Kulynycz 2004). Frequent burning selects against regeneration of pine until they reach about 4 inches dbh (Paul Merten, pers. comm.).

On the other hand, hardwoods are not resistant to fire, so prescribed burning may be detrimental in increasing the hardwood component. Other silvicultural techniques, such as creating small openings by clear-cutting pine around naturally regenerating hardwood saplings and/or replanting hardwoods in these clearings or natural openings, may better meet the objective (Jaime Kellum, USFWS Forester and Robbie Lewis, Accomack Co. Forester, pers. comm.). Conducting an updated forest inventory, evaluating which forested areas have site characteristics (e.g., soil) suitable for supporting hardwoods, and developing silvicultural prescriptions for the most promising sites, is recommended (Jaime Kellum, pers. comm.). Prescriptions may or may not include fire management.

Objective 3.5 Maritime Forest on Assateague Island

By 2015, delineate the boundaries of the maritime upland forest and maritime dune forest community types, and develop appropriate conservation measures.

Rationale: Contained within Assateague Island's 1,600 acres of forested uplands are roughly 400 acres of maritime forest (Berman and Berquist 2007), located primarily in White Hills, Lighthouse, and Woodland Trail areas (Figure 10). This community type is considered globally rare because of restricted range and narrow habitat requirement (Fleming and Patterson 2010). Only 4,093 acres of maritime forest are found in Virginia, 855 acres of this in Accomack Co. (Berman and Berquist 2007). More recently, the Virginia DCR developed a list of the Commonwealth's natural communities ranked according to their conservation priority. Maritime Mixed Deciduous Forest is ranked as "critically imperiled", both globally (G1) and in Virginia (S1). Maritime Loblolly Pine Forest and Loblolly/Beach Heather Dune Woodland are ranked "Imperiled" globally (G2) and in Virginia (S2) (Fleming and Patterson 2010).

The 300 acres described above in Objective 3.4 as loblolly pine/mixed hardwood habitat in the White Hills, Woodland Trail, and Lighthouse compartments is possibly the globally significant Maritime Mixed Deciduous Forest community type. Other forested uplands may be part of the Maritime Loblolly Pine Forest or Loblolly/Beach Heather Dune Woodland communities (Buffa, Pers. Obs). Additional field studies are needed to delineate the boundaries and amount of these important vegetation communities. Silvicultural practices to maintain or enhance the hardwood overstory, sub-canopy, and shrub/herbaceous understory can then be developed to maintain the integrity of maritime forest.

Objective 3.6 Upland Habitats on Wallops Island NWR

Maintain and restore 178 acres of pine/mixed hardwood forest for the benefit of migrating/nesting landbirds, bobwhite, and woodcock. Working with partners such as A & N Electric Cooperative, reduce the number of acres occupied by invasive, non-native autumn olive from 75 to 40 acres by 2015, using mechanical and chemical means.

Rationale: Since its establishment in 1975, Wallops Island Refuge (WINWR) has been unstaffed. Little monitoring or management has occurred except for an annual fall white-tailed deer hunt initiated in 2002, trash pick-up by volunteers, and maintenance of the power line right-of-way by A&N Electric Cooperative. The utility company removes tall growing trees, primarily the non-native autumn olive, and some brush species. Manipulations, with the goal of creating early successional habitat favored by bobwhite and other species that prefer edge and early succession habitats, have occurred in the old-field habitat, but these have been poorly documented. Likewise, some mechanical and chemical treatment of invasive plants also may have taken place (CNWR 2004).

Forested habitats have shown the greatest loss of any cover type on the Delmarva Peninsula, and forest cover on the Peninsula is fragmented (CNWR 2004). Given that most forests in the area are small private woodlots, maintaining an approximately 175-acre block of mature forest with a significant hardwood component would provide an important habitat type for migrant and resident landbirds.

The spread of invasive plant species is the greatest management concern to upland habitat. Invasive plant mapping conducted in 2004 and 2009 identified autumn olive, *Phragmites australis*, Nepalese browntop/ Japanese siltgrass, Japanese honeysuckle, and several thistles as non-native species of concern. Approximately 75 acres of autumn olive was mapped in 2009; one-third of the autumn olive mapped was located in monotypic stands along the forest edge, and two-thirds of the acreage consists of autumn olive invading the understory of the pine/hardwood forest. Japanese siltgrass also covers large areas of the forest understory (Buffa, pers. obs.). Twenty acres of *Phragmites* was mapped in wetlands adjacent to the forest.

Although no documented surveys have been conducted for northern bobwhite or American woodcock on WINWR, suitable habitat exists. Former fields, which are re-vegetating to forests, and the A&N Electrical Cooperative powerline right-of-way, which is maintained in grasses and shrubs, juxtaposed with the pine/mixed hardwood forest fulfills habitat requirements. Although woodcock nesting habitat, described as second-growth hardwood stands near natural openings or roads with an abundance of earthworms for feeding, occur on WINWR, BCR 30 supports a low breeding population when compared to other BCRs (Kelly and Williamson 2008). The Delmarva Peninsula's highest value to woodcock is as a migratory pathway and wintering ground (Kelly and Williamson 2008). Since WINWR's importance to woodcocks is unknown as present, it was not included as a focal species. In fact, because wildlife use at WINWR has not been well inventoried or studied, no focal species were specifically identified for this Refuge. Bobwhite and the general suite of migrant and breeding landbirds listed on Table 3.2 for Forested Uplands and Shrub/Early Successional habitats will serve as focal species until future surveys and studies are completed.

4.3 Goal 4. Southern Barrier Islands Unit (Assawoman, Metompkin, Cedar)

Perpetuate the long-term viability of native avian communities, turtles, and natural habitats on the Refuge's remote barrier islands through a partnership approach.

Objective 4.1 Habitat for breeding species: Assawoman, Metompkin, Cedar Islands
Work with partners that manage other Virginia barrier islands to prevent human disturbance to nesting focal species (piping plover, least tern, and loggerhead sea turtle) on 4.3 linear km of Assawoman, 1.6 linear km of Metompkin, and 10.5 linear km of Cedar Islands during the breeding season. Conduct management actions to minimize mortality and other disturbance factors.

Rationale: The mid-Atlantic barrier islands provide preferred nesting habitat for terns, skimmers, gulls, American oystercatchers, willets, herons, egrets, and other waterbirds (Watts and Paxton 2009). Erwin (1980) found that 81% of seabirds, which include terns and skimmers, in Virginia nest on barrier island

beaches. Many of the avian species that nest, migrate, and winter in the Virginia barrier islands system were nearly extirpated at the turn of the 20th century by a combination of hunting and other human activities. Following protection efforts, the populations of most species utilizing the barrier island system rebounded (TNC 1996).

Nearly all of Virginia's barrier islands are in protected status by a federal, state, or private organization (i.e., The Nature Conservancy- TNC). Despite protective measures, many wildlife species are still in decline, including common terns, least terns, gull-billed terns, black skimmers, American black duck, and several herons. Listed species such as the piping plover depend on barrier island habitats. Documented and potential threats include severe weather events, sea level rise, competition and displacement from nesting habitat by aggressive avian species, mammalian and avian predators, and disturbance from recreational use of barrier islands and salt marsh habitats. It is expected that there will be increasing demand for more public use, possibly placing increased pressure at critical times of the year.

Beaches and dunes are important nesting habitats for shorebirds and turtles, which are sensitive to disturbance. For example, human activities disturb shorebirds, modifying key behavioral traits that are crucial to their survival and reproduction (Burger 1986, Daisey 2006,Defeo et al. 2009), including: (1) changes to foraging behavior resulting in less feeding time, shifts in feeding times and decreased food intake; (2) decreased parental care when disturbed birds spend less time attending the nest, thus increasing exposure and vulnerability of eggs and chicks to predators; and (3) decreased nesting densities in disturbed areas. Substantial evidence shows that human activities also exacerbate natural predation on piping plovers, their eggs, and chicks (USFWS 1995, Daisey 2006). Human activities are associated with increased litter which attracts predators of sea turtle eggs and ground nesting shorebirds (USFWS 2008b). Because the islands are remote and unstaffed, human disturbance has not been measured or monitored. However, the chance that someone landing on one of these barrier island beaches during the nesting season would allow a dog or other pet to run free is possible. Even one dog could harass or kill adults or chicks, potentially wiping out the entire colony's reproductive success in one ill-timed event.

Public recreational activities are restricted to varying degrees on Assawoman, Metompkin, and Cedar Islands during the shorebird breeding season (March 15–August 31) (USFWS 2008b). Pets, personal vehicles, and overnight camping are prohibited on all islands yearlong; however, enforcement of these restrictions on Cedar is problematic because of the intermixed private lands and lack of a boundary survey. The use of motorized vehicles for official duties is minimized on Cedar and Metompkin Islands. USDA personnel occasionally use ATVs to conduct predator management, primarily before nesting begins. Other patrols and biological monitoring are currently conducted on foot or by boat. There is no permanent staffing on any of these islands; Refuge staff visits 3-5 times a week during the height of the nesting season (May-July), and less frequently during other times of the year for the purpose of monitoring shorebirds and conducting law enforcement patrols.

Appendix 8 summarizes activities that are currently permitted on the southern islands. On Assawoman, all public recreation activities are prohibited March 15-August 31 except for persons actively engaged in surf-fishing in designated areas; a permit is required and access is by boat only. Staff posts the southern tip of Assawoman, where most public use occurs, with "Closed – Sensitive Nesting Area" signs and rope. However, trespassing is documented each breeding season; boaters land and walk behind the closed area signs, and others beach comb or sunbathe in the area where only fishing is allowed.

On Metompkin, sensitive bird nesting areas on the northern tip are posted with closed area signs and rope by Refuge staff prior to the nesting season. Fishing, sunbathing, beach combing, wildlife observation, and picnicking are allowed outside of the closed areas; access is by boat. As with Assawoman, trespass and disturbance of nesting birds is noted each year.

The intermixed public and private ownership and lack of a complete boundary survey on Cedar Island limits staff's ability to enforce restrictions on this island. Most wildlife-dependent public uses are allowed; however, because it is more remote than either Assawoman or Metompkin and accessible only by boat, it is less visited by the public. Two private parties own land and vacation on Cedar Island. One

party is very conscientious about minimizing wildlife disturbance, keeping dogs on leashes and avoiding shorebird breeding areas. The other private party is not particularly sensitive to protecting shorebird breeding habitat; he maintains a vehicle on the island and drove through a nesting colony in 2009. In response, CNWR staff placed "Area Closed" signs around several areas where breeding birds concentrate on Cedar Island to protect nests and alert visitors to potential nests and chicks in the area.

The differences in permitted activities, dates of restrictions, and differing policies of the various agencies and organizations that manage the barrier islands also may make it hard for the public to understand and abide by restrictions. Working with partners to develop consistent rules and signage, and directing public use to less sensitive areas would help meet this goal.

Objective 4.2 Habitat for migrating/wintering shorebirds: Assawoman, Metompkin, Cedar Islands

Over the next 15 years, preserve sandy beach and overwash habitat along on 4.3 linear km of Assawoman, 1.6 linear km of Metompkin, and 10.5 linear km of Cedar Island, and tidal marshes on the backside of the islands to benefit migrating and wintering focal species (red knot, sanderling, American oystercatcher, whimbrel), and other shorebirds of conservation concern.

Rationale: The ecological significance of Assawoman, Metompkin, and Cedar Islands is recognized through their inclusion in the Western Hemisphere Shorebird Reserve Network (WHSRN) as a site of international importance, and by their designation as part of a Biosphere Reserve. In excess of 100,000 shorebirds migrate along the barrier islands and bays during fall and spring migration (The Nature Conservancy 1996), including species of high or highest conservation concern (Appendix 1).

The Refuge's southern barrier islands are particularly important as spring stopover sites for migrating red knots between late April to early June, with numbers peaking in late May (Watts et al. 2008a). Virginia hosts approximately 30% of the hemisphere's red knot *rufa* sub-species population, and Cedar and Metompkin Islands fall in the upper third of islands in terms of numbers of red knots counted during migration (The Nature Conservancy, unpubl. red knot survey data 1995 – 2009).

The Refuge does not currently conduct or organize systematic winter/migratory shorebird surveys on the southern islands like those conducted by volunteers on Assateague Island. Aside from the winter American oystercatcher roost-site surveys (conducted over the past several winters by VDGIF and TNC), the level of non-breeding season surveys conducted by partners is unknown. The Wachapreague Christmas Bird Count includes Cedar Island, and a volunteer party walks the entire island and counts all birds seen and heard during this one-day survey which takes place in mid-December.

Objective 4.3 Maintain natural coastal processes and the integrity of natural habitats on Assawoman, Metompkin, and Cedar Islands

Allow and advocate for natural and dynamic coastal processes as the primary forces that shape the southern barrier islands habitats and species composition. Protect and manage for important or rare natural communities and species.

Rationale: Stretching from Maine to south Texas, the barrier island system of the Atlantic and Gulf Coasts forms a protective fringe for some 2,700 miles of the nation's shoreline. Virginia's string of barrier islands, which extend from Assateague Island south to Fisherman Island at the mouth of the Chesapeake Bay, is the largest collection of near pristine barrier islands left in the country (USFWS 1988). Its ecological significance has been recognized by the United Nations through its designation as a "Man and the Biosphere Reserve" (The Nature Conservancy 1996). Aside from small private in-holdings, all of Virginia's barrier islands are protected by either federal or state agencies, or The Nature Conservancy. These partners developed a Conservation Action Plan in 1996 with a goal, "To ensure the long-term viability of the avian communities, species, and habitats in the Virginia barrier islands system through a partnership approach" (The Nature Conservancy 1996).

Seabeach amaranth (*Amaranthus pumilus*) is a rare plant native to Atlantic coast barrier island beaches; historically it occurred from Massachusetts to South Carolina (USFWS 2008c). Although preferred habitat for seabeach amaranth is found on Refuge barrier islands, it's only known currently from Assateague Island (Table 2.2). No plants were found on Assawoman during a 2009 or 2010 survey (unpubl. Refuge data). However, since the species favors recently over washed beaches for germination, the probability that a single survey would have overlooked this inconspicuous plant is high. Potential habitat on Cedar and Metompkin islands has not been surveyed.

Conducting a feasibility study to determine if a transplant program to establish seabeach amaranth on southern barrier island(s) sites is desirable would help meet the goals of the Recovery Plan (USFWS 1996). The recovery objective is to have 75% of sites with suitable habitat within each state occupied for 10 consecutive years; Virginia is one of the target states (Weakley et al.1996 and USFWS 1996).

Chapter 5. Management Strategies

- Coastal Habitats
  Piping Plover and Least Tern
  Migrating & Wintering Shorebirds
  Loggerhead Sea Turtles
  Seabeach Amaranth
  Salt Marsh Habitats
  Sea-level Fen
  Tidal Creeks, Estuary, Marine Waters

- Managed Wetlands (Impoundments)
  Waterfowl, Shorebirds & Waterbirds
  Impoundment Restoration for Black Ducks
  Monarch Butterflies
  Artificial Structures

- Upland Habitats
  Shrublands for Landbirds
  Monarch Butterfly Nectar Sources & Roosts
  Roadsides & Dikes: Squirrels, Ground-nesters
  Forested Uplands for Squirrels, Brown-headed Nuthatch, Eastern Towhee
  Wallops Island NWR

- Southern Barrier Islands
  Assawoman, Metompkin and Cedar

5.1 Goal 1. Coastal Habitats

Objective 1.1 Beach/Dune Nesting Shorebirds (all islands): Piping Plover & Least Tern

Provide sandy beach, dune edge, washovers, and intertidal areas on Assateague, Assawoman, Metompkin, and Cedar islands, and reduce mortality factors, to maintain a Refuge-wide piping plover fledge rate between 1.2 and 1.5 chicks per pair as averaged over a 10-year period. If fledging rate drops below 1.0 chicks per pair over a 10-year period, management strategies and prescriptions will be re-evaluated using a formal process and outside expertise.

MANAGEMENT STRATEGIES:

1.1.1 Reduce mortality and disturbance factors on Assateague, Assawoman, Metompkin, and Cedar beach, dune, and overwash areas during the breeding season: March 15 through August 31, or until the last chick fledges.

- Until the CCP is completed, implement off-road vehicle (ORV) and pedestrian closures as outlined in the 2008 Biological Opinion (USFWS 2008c): 1) Close Toms Cove Hook to ORVs from March 15 through August 31 or until the last chick fledges thereafter; 2) Close the Overwash nesting area March 15 through August 31; 3) Close the Overwash ORV zone 200 m north of any shorebird broods; 4) Close Wild Beach to pedestrian use above the high tide zone March 15 through August 31.
- Post closures with signs and symbolic fencing (rope strung between sign posts)
- In conjunction with the 1993 Master Plan (CNWR 1993), reduce footprint of current public beach parking area by providing parking for beach users in an areas less sensitive for wildlife habitat and more stable to the forces of the tides and storms.
- Through the CCP process, explore ways that a wildlife-dependent recreation use (i.e., surf-fishing) can be conducted in a way that reduces its impacts on beach nesting birds. For example, all ORV users could be required to be actively engaged in surf fishing, or ORV use for surf-fishing access could be confined to a smaller area.

1.1.2 Continue to minimize direct predation of piping plover, least tern, American oystercatcher, and other beach nesting birds.

- Erect exclosures around individual plover nests where necessary and logistically feasible. (Costs in terms of staff effort outweigh benefits on nesting islands accessible only by boat, where predation levels are low or nil such as Cedar and Metompkin).
- Remove mammalian nest predators (primarily foxes and raccoons) from nesting habitat and nearby areas and travel corridors prior to and during the breeding season.
- Remove avian predators, such as gulls and corvids, from nesting areas when chicks are present, at other times of the breeding cycle, when needed.
- Conduct an analysis of the Refuge's predator control efforts and results to develop recommendations to improve its effectiveness. The analysis should be done in conjunction with other partners' analyses of predator management results on other islands to better understand system-wide responses to reductions in island predator populations.

1.1.3 Continue removal of *Phragmites,* Asiatic sand sedge (*Carex kobomugi*) and other invasive vegetation by mechanical, chemical, or other means. Annually treat at least 50% of the existing *Phragmites* on the Hook, and treat *Phragmites* on Assawoman, Metompkin and Cedar bi-annually, or as funding allows. Use outcomes of the *Phragmites* Structured Decision Making group to refine this strategy.[5] Remove *Carex kobomugi* whenever it is found; patches

[5] The *Phragmites* SDM workgroup my change invasive species management strategies in Region 5, and CNWR.

of this highly invasive species are still small enough and occur infrequently to employ a zero tolerance policy.

1.1.4 By 2012, contract a coastal geologist or hydrologist to model the impacts of storm flooding events and other dune breaching scenarios on Assateague Island to evaluate potential effects that removal of the artificial dunes may have on natural and manmade habitats, Refuge infrastructure, and flood control for the town of Chincoteague. The study would also guide the design of natural or engineered breaks in the artificial dunes to restore overwash and their natural processes.

1.1.5 Allow natural geologic processes to restore overwash to a northern portion of Wild Beach (e.g. North Wash Flats Impoundment) on Assateague Island in order to increase nesting habitat for plover, least terns, sea turtles, and other nesting shorebirds lost when the artificial dune system was created. This will also allow natural island movement, which will buffer the effects of sea level rise and future storms on other wildlife habitats. Locations of natural or artificial breaches to allow such overwash would be determined by the study outlined in Strategy 1.1.4.

1.1.6 Work with the NPS to replace existing trash bins in parking lots around public beach areas on Assateague Island with a design that excludes bird and mammal predators and scavengers.

1.1.7 Work with Visitor Services staff to develop educational and outreach programs that foster a public appreciation of nesting shorebirds and inspire Refuge visitors to reduce their impacts on these species. Implementing a "Shorebird Sentry" program in 2011 or using the "Shorebird Sister School" program to deliver this message are examples.

MONITORING STRATEGIES:

1.1.8 Continue to annually monitor reproductive success of piping plover pairs on all islands, which includes determining the number of breeding pairs, nests, and chicks fledged.

1.1.9 Determine the number of American oystercatcher pairs and fledge rate for all islands. Conduct more intensive monitoring of oystercatchers (e.g. # nests, hatch success, cause of failure) on one island per year on a rotating basis.

1.1.10 Annually monitor the number of nesting pairs/nests of least terns, common terns, Forster's terns, and black skimmers on all islands using methods outlined by the Atlantic Coast Least Tern Adult Window Count and Virginia Colonial Waterbird Coastal Plain Survey.

1.1.11 Annually conduct scouting for invasive plant species on all islands in conjunction with bird monitoring Strategies 1.1.8 through 1.1.10; train interns and bio techs on how to identify invasive plant species of concern. Evaluate the success of Refuge treatment programs using the Virginia Dept. Conservation and Recreation's periodic aerial *Phragmites* mapping.

1.1.12 Continue to conduct annual predator scent station monitoring in November to determine predator trends and guide predator pre-breeding season control activities.

Objective 1.2 Beach/Dune Habitat for Migrating and Wintering Shorebirds

Over the next 15 years protect and enhance sandy beach, overwash, dune grassland habitat along 21.6 km of Assateague Island (Hook, Overwash, Wild Beach) and tidal flats along Toms Cove to benefit red knots, sanderlings, and other migrating/wintering shorebirds of conservation concern, by regulating and directing public use to less sensitive areas, away from roosting and feeding areas during peak migration.

MANAGEMENT STRATEGIES:

1.2.1 Reduce human disturbance by redirecting beach ORV use so that it avoids sensitive shorebird roosting/feeding areas and/or occurs less frequently during shorebird migration periods. For example, only allow beach ORV use 3 days a week and/or eliminate night driving on the beach, and/or extend the ORV closure on Toms Cove Hook so that it encompasses the entire shorebird fall migration period (July-September).

1.2.2 Conduct education and outreach programs to educate people, particularly pedestrians on the beach, how to reduce their disturbance impact on birds. For example, teach them to walk around flocks of shorebirds and observe wildlife from a distance.

1.2.3 If ORV driving on the beach is allowed to continue, require that Beach Driving Permit holders attend an orientation session on how to minimize their impact on wildlife. This could be modeled after the Refuge's successful hunt orientation program.

MONITORING STRATEGIES:

1.2.4 Continue weekly shorebird surveys April-May and July-September, and every-other-week surveys Oct-March and June. Since patterns of shorebird use of impoundments are related to the tidal cycle (Haines 1999) and beachfront is only accessible at low tide, adjust protocol to obtain the most complete count of all surveyed units on Assateague. This can best be accomplished by starting the shorebird survey one hour before low tide on Toms Cove/Hook, then proceeding north on Wild Beach to the beach access road north of Old Fields, and continuing south after surveying Old Fields to complete the remainder of the impoundments. Surveys on the impoundments will thus occur during mid and high tide, when shorebird activity was found to be the highest (Haines 1999).

1.2.5 Continue re-sight surveys for tagged red knots in fall and spring in conjunction with weekly shorebird surveys and plover/oystercatcher breeding surveys, and using protocols consistent with partners involved with red knot monitoring and research.

1.2.6 Continue bi-weekly re-sight Chincoteague Bay boat surveys for color-banded American oystercatchers in fall and winter in partnership with VDGIF and TNC. Prior to 2015, re-evaluate the resources available for this survey, which takes place off-Refuge, and the information gained to determine if surveys will continue.

Objective 1.3 Beach/Dune Habitat for Turtles

Protect a minimum of 21.6 linear km of sandy beach habitat on Assateague Island for nesting loggerhead sea turtles. Continue *in situ* nest protection such that no more than 3 nests over any 5-year period, and no more than one in any given year, are lost to human or predator-related causes.

MANAGEMENT STRATEGIES:

1.3.1 Control human disturbance along 21.6 km of Assateague Island during the turtle nesting season.

- Continue implementing ORV and pedestrian closures on the Hook, Overwash, and Wild Beach March 15 through August 31 as outlined in the 2008 Biological Opinion (USFWS 2008c) and summarized in 1.1.1 above.
- Erect "Area Closed" signs and symbolic fencing (rope strung between signs) in a buffer zone (minimum 5-foot radius) around all nests, and maintain these protective measures until the nest hatches or is determined to be unviable.

- Reduce, restrict, or eliminate nighttime permitted beach driving during the entire sea turtle nesting season (June-October).
- Night driving of official vehicles (FWS and NPS) on the beach will be avoided to the greatest extent possible during the turtle nesting season.

1.3.2 Protect sea turtle nests from predators by placing predator screens over all nests and conducting mammalian and avian predator control as outlined in 1.1.2 above.

1.3.3 Restore dynamic beach and overwash system on Assateague Island by allowing natural geologic processes to restore overwash to a northern portion of Wild Beach in order to increase nesting habitat for sea turtles lost when the artificial dune system was created.

MONITORING STRATEGIES:

1.3.4 Conduct sea turtle crawl and nest searches of Assateague beaches at least 3 times per week June through August, in conjunction with shorebird monitoring activities whenever possible.

1.3.5 Properly trained staff will determine whether sea turtle crawls resulted in a nest and will monitor all confirmed nests for hatching and emergence as described in the Biological Opinion (USFWS 2008c).

Objective 1.4 Beach Habitat for Seabeach Amaranth (Amaranthus pumilus)

Maintain and expand sandy beach and washover habitat for Seabeach Amaranth along Assateague shoreline by allowing natural process to occur with a goal of increasing the number of plants, as averaged over a 5-year period. By 2015, investigate whether it is feasible and desirable to increase the number of sites occupied by seabeach amaranth from one to two sites by active management such as propagation/ transplanting, re-seeding, or removing artificial dunes that prevent suitable habitat from forming at the north end of Assateague.

MANAGEMENT STRATEGIES:

1.4.1 Continue to erect protective cages around amaranth plants each year.

1.4.2 Within 3 years of plan implementation, evaluate NPS amaranth propagation/transplant methods and success elsewhere (AINS, NC), and seek guidance from USFWS Seabeach Amaranth Coordinator to determine whether such methods should be used to establish another population on the Hook. Seek partners for implementing a transplant program if determined feasible.

1.4.3 Following results of a geology/hydrology study (1.1.4) restore dynamic beach and overwash system, particularly in the Wild Beach area, in order to increase seabeach amaranth habitat lost when the artificial dune system was created.

MONITORING STRATEGIES:

1.4.4 Continue the annual August inventory of Assateague Island beaches for amaranth, in cooperation with NPS-AINS personnel whenever possible. Conduct inventories on Assawoman every three to five years.

1.4.5 Scout for Asiatic sand sedge, and other invasive species, in conjunction with amaranth and plover surveys. Map any patches with handheld GPS and remove them by chemical or mechanical methods as soon as practical.

Objective 1.5 Salt Marsh Habitats for Nesting, Migrating, and Wintering Birds

Maintain 2,875 acres of salt marsh in Assateague, Morris Island, and Wildcat Marsh Units, and 195 acres on Wallops Island NWR to ensure the quality and natural function of the marsh are sustained and provide breeding, wintering, foraging, and migrating habitat for nesting species such as clapper rail, saltmarsh sparrow and American oystercatcher, wintering species such as American black duck, and migrating shorebirds. This habitat will include a mix of high and low salt marsh vegetation, pool, mudflat, and panne habitat containing less than 5% overall cover of non-native invasive plants. Where this habitat type is degraded by non-native ponies, sika elk, or other factors, enhance its ecological integrity using Region 5's salt marsh ecological integrity index (currently being developed) by 2020.

MANAGEMENT STRATEGIES:

1.5.1 Continue removal of *Phragmites* (and other invasive vegetation) by chemical, mechanical or other means. Annually treat at least 50% of the existing infested acreage, or as funding allows. Use outcomes of the *Phragmites* Structured Decision Making group to refine this strategy.

1.5.2 Continue to use Refuge education programs and outreach efforts to educate visitors, hunters, and other groups about how they can help decrease the spread of invasive plants.

1.5.3 By 2012, conduct a condition assessment of grazed vs. un-grazed (by ponies) salt marsh on the Refuge (perhaps using Wildcat Marsh or Morris Island as comparison sites). Work with the Chincoteague Volunteer Fire Department and others with technical expertise in grazing systems. Adjust grazing compartments and/or pony numbers in order to reduce the adverse effect of ponies on the habitat of focal species, and determine if pony grazing can be integrated into impoundment management strategies.

1.5.4 By 2012 evaluate existing studies conducted by the NPS, Refuge and others on the effects of pony grazing on wildlife and habitat, including the effects of compaction, to identify information gaps. Seek funding and encourage graduate students or cooperators to undertake studies with an applied management focus.

1.5.5 Within 3 years of plan implementation, identify high priority salt marshes that support priority focal species (clapper rail, seaside sparrow, and black duck) and/or contribute to the long-term integrity of the salt marsh ecosystem.

1.5.6 Within 5 years of plan implementation, work with partners (Ducks Unlimited, Black Duck Joint Venture, VDGIF) to identify additional habitat restoration projects that can be done to enhance/restore habitat for black ducks.

1.5.7 Encourage partners (Center for Conservation Biology (CCB) College of William and Mary, USGS, VDGIF) to conduct studies to better understand the distribution and abundance of saltmarsh sparrows on the Refuge, and help identify their limiting factors and other threats. (e.g. develop Challenge Cost-Share project in 2011 with Fletcher Smith of CCB to study saltmarsh sparrow breeding on CNWR and continue to support winter mercury study.)

MONITORING STRATEGIES:

1.5.8 Continue to map and track the changing acreage of *Phragmites* on at least a bi-annual basis and use the results to prioritize treatments (1.5.1).

1.5.9 Within 5 years, implement a survey protocol (building on CCB study or Region 5's Salt Marsh Integrity Study) to monitor population trends and densities of saltmarsh, Nelson's and seaside sparrows, and clapper rails in high priority salt marshes.

1.5.10 By 2011, install Surface Elevation Tables (SET) that monitor marsh elevation rates to complement but not duplicate the SETs monitored by the NPS on the MD side of Assateague.

Use these data, along with sea level change models, to predict changes in amount/distribution of tidal marsh, and adjust management actions as needed

1.5.11 Within 7 years, integrate the findings from Strategy 1.5.5, the locations of SETs in Strategy 1.5.10, and the Regional salt marsh integrity protocol, to a design a marsh monitoring program that includes a feedback loop and adaptive management restoration actions to improve salt marsh quality and integrity.

Objective 1.6 Sea-level Fen on Wallops Island NWR

Over the 15-year life of the HMP, protect the integrity of Lucky Boy Fen by maintaining and enforcing the public closure around the perimeter of the quarter-acre area, protecting the freshwater recharge, maintaining forest cover upslope, and ensuring that invasive non-native vegetation does not exceed a threshold of 5% cover.

MANAGEMENT STRATEGIES:

1.6.1 Annually in early November, prior to the deer hunt, check closed area signs around fen and re-post with closed area signs and symbolic fencing (rope strung between posts) if necessary.

1.6.2 During the 2011 growing season, and/or in conjunction with Virginia DCR's next survey, accurately map the boundaries of the Lucky Boy Fen and a buffer area of sufficient width around the perimeter to protect it from human disturbance and other perturbations.

1.6.3 Within 5 years, consult the literature and experts in fen management to determine whether the myrtle shrubs and other woody plants in and near the fen pose a threat to the rare plants in this unique habitat type, and determine best management practices to address any problems.

1.6.4 When conducting any chemical treatment of invasive plants in uplands adjacent to Lucky Boy Fen, take extreme care in preventing overspray; spray only on windless days and use a wicking wand (e.g. "Sideswipe Pro Herbicide Applicator" available from Forestry Supply). Insure that ANEC staff conducting management of invasive plants in their ROW are aware of the fen's location and precautions needed.

1.6.5 Collaborate with stakeholders and adjacent landowners such as VA Dept. of Transportation (DOT) and NASA Wallops Flight Facility (WFF) to monitor and preserve the integrity of the Lucky Boy Fen. For example, WFF has an Integrated Contingency Plan which details storm water pollution prevention and spill control measures; contact DOT to see if they have measures to prevent run-off from Route 175 from degrading the fen.

MONITORING STRATEGIES:

1.6.6 In summer 2011, and at least every third year thereafter, coordinate with Virginia DCR personnel to survey rare plants present during the growing season. Monitoring surveys were previously conducted in 2003 and 1992.

1.6.7 Monitor for invasive plants during rare plant assessments (Strategy 1.6.6).

1.6.8 Within 5 years of plan implementation, initiate simple ground or surface water monitoring at Lucky Boy Fen to determine if pollutants are present, and identify potential limiting factors such as nitrogen or alkalinity. A recommended protocol involves first taking a grab sample to establish a baseline and test for nutrients (Sue Adamowicz, Biologist, USFWS). Depending on the results, a simple perforated PVC tube ground water monitor or small surface collector (resembles a dustpan) could be installed.

Objective 1.7 Tidal Creeks, Estuaries, Mudflats, and Nearshore Marine Waters

Protect the ecological integrity of these habitats through an active role in local, state, and federal partnerships, and make sure that USFWS trust species' needs are addressed in decisions and actions affecting areas within the focus areas of Chincoteague and Wallops Island NWRs.

MANAGEMENT STRATEGIES:

1.7.1 Continue an active role in the Virginia Coastal Avian Partnership (VCAP).

1.7.2 Work with other members of the VCAP to conduct education and outreach programs targeted at eco-tour operators and other boaters on how to minimize their disturbance to colonial and other ground-nesting birds (e.g. tour boats that land clients on oyster shell rakes during breeding season).

1.7.3 Within 2 years of plan implementation meet with NPS Toms Cove Visitor Center Staff and Refuge Visitor Service's staff to explore ways of meeting this objective through marsh and estuary programs and other public outreach activities.

1.7.4 Through the Refuge's monthly Community Leaders Meeting, continue to inform local political leaders, tourism councils, and sister agencies about trust resources that use the Refuge and actions they can take to protect and enhance the ecological integrity of Chincoteague Bay and adjacent habitats.

1.7.5 Conduct outreach or form a collaborative partnership with Watermen in Chincoteague Bay aimed at eliminating or cleaning up netting that washes up on Refuge habitats.

1.7.6 Participate in watershed, water quality, and other planning meetings hosted by the county, city, and other similar agencies/organizations.

MONITORING STRATEGIES:

1.7.7 In Summer 2010, collect a third year of breeding American oystercatcher data on the Chincoteague Bay Boat Route, and coordinate with partner agencies to determine the frequency of future productivity monitoring on this route.

1.7.8 Within 5 year of plan implementation meet with NPS staff monitoring water quality around Assateague Island and Chincoteague Bay to determine how their monitoring results can be use to help meet this objective, and how the Refuge can better support NPS water quality monitoring efforts.

1.7.9 Within 3 years of plan implementation, collaborate with the USFWS Maryland Fisheries Office, Virginia Inst. of Marie Science, Marine Science Consortium (MSC), and/or other technical experts to develop a fish monitoring program (that includes frequency, location, and protocols) aimed at monitoring Refuge fisheries population and water quality implications.

1.7.10 Continue to share monitoring data with adjacent and sister agencies and organizations such as VDGIF, The Nature Conservancy, NASA Wallops Flight Facility Managers, and NPS-AINS.

5.2 Goal 2. Managed Wetlands (Impoundments)

Objective 2.1 Impoundments for Waterfowl, Shorebirds and Waders

Provide approximately 2,650 acres of quality wetland habitat to support wintering waterfowl, spring migrating shorebirds, breeding shorebirds and waterbirds, and fall migrating shorebirds and waterfowl

until Structured Decision Making (SDM) restoration criteria are met. A Water Management Plan, detailing management prescriptions to achieve objectives listed below, will be prepared annually. Refuge staff will continue to monitor and assess each impoundment using use the Coastal Impoundment SDM model to evaluate whether to continue managing it for current capabilities (see Table 5.1), or to restore it to a natural, unmanaged hydrology. Taxa-specific objectives may be rotated among impoundments from year to year depending on environmental conditions and impoundment capabilities, and will be directed to provide the following:

(1) Manage 55-75% of the impoundments' surface area each winter (December through mid-March) to provide shallow flooded (<12" water depth) and seed-producing moist-soil vegetation for wintering waterfowl including black duck, pintail, gadwall, shoveler, teal, and snow geese.

(2) Manage 35-50% of the impoundments' surface area each spring (April-May), and 25-40% each early fall (July-October) to provide a mix of 40% mudflat and shallow water (<4" water depth) with sparse vegetation (<15% cover) for migrating shorebirds (e.g., short-billed dowitcher, dunlin, semipalmated sandpiper, yellowlegs).

(3) Manage 40-50% of the impoundments' surface area each fall (late October through November) for migrating waterfowl (e.g., black duck, green-winged teal, blue-winged teal) to provide shallow flooded (<12" water depth) annual vegetation composed primarily of *Scirpus, Echinochloa, Polygonum, Bidens* and other seed producing moist soil vegetation at time of peak migration and by controlling invasives.

(4) Manage North Wash Flats impoundment to provide 90% dry habitat conditions for breeding piping plover, Wilson's plover and least terns between March 15 and September 1, or until all chicks are fledged.

(5) Provide concentrated food resources in at least 2 impoundments during June-August each year for breeding waterbirds such as snowy egrets, glossy ibis, and herons.

Table 5.1 Impoundment management capabilities for focal species.

			LIKLIHOOD OF ACHIEVING MANAGEMENT OBJECTIVES FOR:					
Impoundment	**Acres**	**Year Built**	**Spring Shorebirds**	**Fall Shorebirds**	**Fall Waterfowl**	**Winter Waterfowl**	**Feeding Waterbirds**	**Monarch Nectaring**
A-Pool	105	1952	YES	YES	YES	YES	YES	NO
B-Pool (South)	371	1952	YES	YES	YES	YES	YES	YES
B-Pool (North)	94	1952	YES	YES	YES	YES	YES	YES
C-Pool	69	1954	YES	YES	NO	YES	NO	YES
D-Pool	16	1954	NO	NO	NO	NO	NO	YES
E-Pool	26	1962	NO	NO	NO	YES	NO	YES
F-Pool	409	1962	YES	YES	YES	YES	YES	NO
Sow Pond	48	1963	NO	NO	NO	YES	NO	NO
Wash Flats (N)	793	1963	NO	NO	YES	YES	NO	NO
Wash Flats (S)	279	1963	YES	YES	YES	YES	YES	NO
Ragged Point	38	1964	NO	NO	NO	YES	NO	NO
Old Fields	368	1954	YES	YES	YES	YES	YES	NO
Farm Fields	35	1992	NO	NO	YES	YES	NO	NO
TOTAL "yes"	**2,651**[6]		**7**	**7**	**8**	**12**	**6**	**5**

[6] Impoundment acres in Table 5.1 include the entire area between the dikes. It differs from the Impoundment Unit acres (2,012) in Table 2.3because the latter was derived from a vegetative cover map, which mapped the water, mudflat, and wetland vegetation as "impoundment". The woody vegetation within the impoundment dikes was placed in the Shrub/Early Successional category.

MANAGEMENT STRATEGIES:

2.1.1 During the initial 4-5 years of the HMP, or until refined by the outcome of the SDM model, this objective will be met by manipulating impoundment water depths and vegetation. Table 5.1 summarizes which impoundments have the capabilities to achieve the following:

(1) Manage at least 10 impoundments each winter (Dec through mid-March) to provide 100% shallow flooded (<12" water depth) and seed-producing moist-soil vegetation for wintering waterfowl including black duck, pintail, gadwall, shoveler, teal, and snow geese.

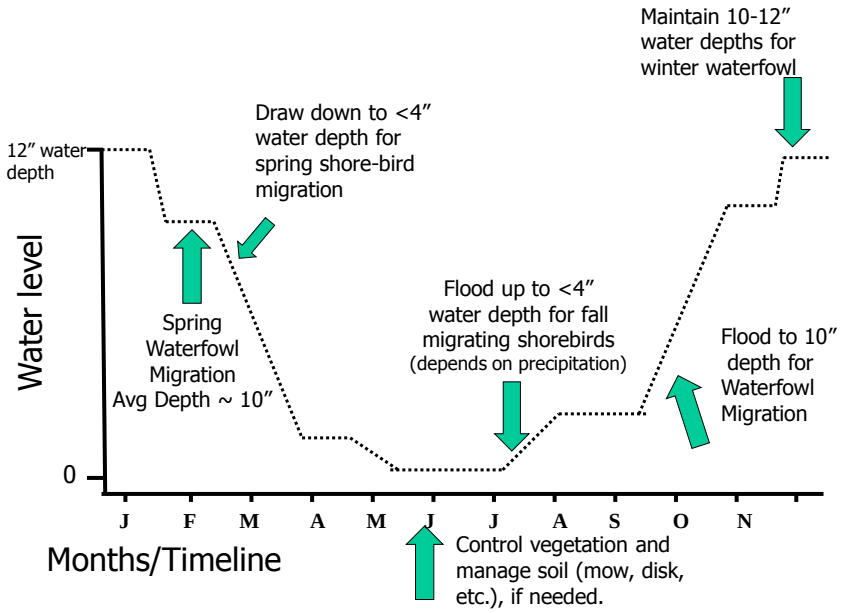
(2) Manage at least 4 impoundments each spring (April-May) and 3 each fall (July-October) to provide a mix of 40% mudflat and shallow water (<4" water depth) with sparse vegetation (<15% cover) for migrating shorebirds (e.g., short-billed dowitcher, dunlin, semipalmated sandpiper, yellowlegs).

(3) Manage at least 6 impoundments each fall for migrating waterfowl (e.g., black duck, green-winged teal, blue-winged teal) to provide shallow flooded (<12 inches) annual vegetation composed primarily of *Scirpus, Echinochloa, Polygonum, Bidens* and other seed producing moist soil vegetation at time of peak migration (late October to early November) and by controlling invasive species

(4) Manage North Wash Flats impoundment to provide 90% dry habitat conditions for breeding piping plover, Wilson's plover and least terns between March 15 and August 31, or until all chicks are fledged.

(5) Manage at least 2 impoundments during June-August to provide suitable feeding areas (ponded areas or borrow ditches that concentrate fish) for nesting waterbirds such as glossy ibis, egrets, and herons.

Figure 11 Diagram of Typical Impoundment Water Level Management (Modified from USFWS 2005)



Summer/Fall Re-flood Prescription (See also Figure 11).

In most years, impoundments managed for spring and fall shorebirds and winter waterfowl (i.e. ponds A, B-South, B-North, C, F, South Wash Flats, and Old Fields) will start the annual cycle with a partial

drawdown beginning in March, prior to the arrival of spring shorebird migrants. The goal of the drawdown is to slowly and continuously expose new mudflat and shallow water habitats. Target water levels (<4") will be maintained throughout the passage of birds, April through May. The impoundments will be at lowest water levels possible by the end of spring shorebird migration (early June) and will remain low to allow the possibility of vegetation manipulation using heavy equipment. Shorebird habitat will be created by allowing precipitation to re-flood impoundments before the arrival of southbound shorebirds (July), as precipitation allows. Mudflat and shallow-water habitats will be maintained during shorebird passage (August through September). Water-levels will be increased in October before the arrival of early southbound waterfowl, and returned to full-pool by November, or as precipitation allows. D-Pool, E-Pool, and Farm Fields support few shorebirds, but since they are connected in series to other ponds, their water levels will be managed in spring and fall to facilitate the objectives in the shorebird-managed ponds.

2.1.2 Draw-down North Wash Flats (NWF) impoundment beginning February 15 each year by a combination of pumping and constructing/maintaining shallow ditches. Continue to evaluate NWF impoundment's contribution to plover reproductive success in the annual shorebird report; if it determined that these efforts are not contributing to plover recovery or benefitting other species, develop alternate management prescriptions for NWF and an alternative mitigation plan with USFWS Ecological Services.

2.1.3 On alternate years, enhance piping plover nesting habitat in NWF by various methods which may include placing clam shells, constructing low-profile nesting islands, flooding and/or disking/mowing/burning to remove vegetation. Specific prescriptions will be spelled out in the annual water management plan.

2.1.4 Within 3 years of HMP implementation, fine-tune water level management capability by completing a bathymetric survey of all impoundments and by 2012 complete a map of all pond bottoms so that water depths can be better related to water gauge readings.

2.1.5 Encourage growth of desirable waterfowl food plants in impoundment bottoms, while balancing the need to maintain a certain amount of woody vegetation along pond edges for black duck thermal cover and songbird habitat. Annual water management plans will prescribe where and how frequently to remove encroaching woody vegetation through mowing, disking, prescribed burning and/or hydroaxing. Vegetation treatments will occur on a rotational basis, with 2-4 impoundments being manipulated each year. Avoid mowing or disking any areas with *Phragmites* because it spreads this invasive.

2.1.6 Control *Phragmites australis* and other invasive species, through integrated pest management, including herbicide application and prescribed burning. Annually treat at least 50% of existing, infested areas, or as funding allows. The priority will be to treat outlying patches and perimeters first, to prevent the spread into new areas. Almost of high a priority will be to continue to hit previously treated areas, at least on a bi-annual basis, as treatment every other year with Imazapyr herbicide may be most effective in preventing rhizome spread (Bob Leffel, ESVNWR and Habitat® manufacturer, pers. comm.). Refine this strategy based on the outcome of the *Phragmites* SDM model.

2.1.7 Prescribe burn, on a rotational basis, 150-300 acres in impoundments annually. This is based on the acres of impoundments covered by burnable vegetation (1500 acres) divided by the fire return interval in this habitat type (Tim Craig, USFWS Fire Mgmt, pers. comm.)

2.1.8 Within 3 years of HMP completion, and in conjunction with Strategy 1.5.3, evaluate whether pony grazing can be used more effectively to meet habitat needs of focal species and adjust grazing compartments and/or pony numbers in order to accomplish this.

2.1.9 Between 2010 and 2015, use outcomes from the Integrated Waterbird Project, R3/R5 Impoundment Study, and the Coastal Impoundment SDM Model to refine management strategies for impoundments.

2.1.10 Continue to reduce, eliminating if possible, populations of resident Canada geese (i.e. those breeding on the Refuge during spring/summer) through egg-addling, annual round-ups and shooting. Control measures should be timed to take place before migrants begin arriving (September). Support the Town of Chincoteague's efforts to reduce goose populations, since geese nesting and loafing in town areas move to the Refuge.

2.1.11 Any proposals to allow additional hunting or public access on or near Refuge impoundments during fall/winter should be carefully evaluated to avoid potential impacts to black duck loafing and feeding areas because impoundments provide an important daytime habitat component free from human disturbance. Morton et al. (1986) found that black ducks moved each morning from salt marsh in Chincoteague Bay to Refuge impoundments to avoid disturbance from oystermen, fishermen, hunters and car/boat traffic.

MONITORING STRATEGIES:

2.1.12 Continue monitoring for waterfowl, shorebirds, and waders on CNWR impoundments and adjacent tidal areas as per the CNWR Inventory and Monitoring Plan.

2.1.13 Within 1 year of HMP completion, analyze 20-year data set of bird use in comparison to water levels and precipitation. Use this data to identify which ponds have the most potential to manage for different groups of birds.

2.1.14 Continue to collect bi-weekly water level and salinity readings for each impoundment throughout the year. Water gauge readings will be used to adjust impoundment to proper depth for target species use, and to conduct / evaluate water level manipulations as identified in annual work plans. Periodically calibrate and test the instrument on a known salinity sample before collecting field data.

2.1.15 Conduct vegetative transects at fixed sampling points in each impoundment in order to monitor the effectiveness of water level management/vegetation management for achieving bird and monarch objectives (e.g. *Bidens laevis* cover*)*. Use the results to evaluate vegetation response to management actions, adjust prescriptions in the Annual Water Management Plan.

2.1.16 Continue to map *Phragmites* patches in and adjacent to impoundments bi-annually, at a minimum, and annually the year following any major treatment such as aerial spraying or prescribed burning. Use results to prioritize treatment areas.

2.1.17 As a supplement to 2.1.15 and 2.1.16, conduct observational walks within the impoundments following mechanical/chemical treatments or water level manipulations to qualitatively assess whether desired results are being achieved. Also scout for invasive species and estimate overall vegetative composition of the impoundments. Observations will be logged in the Refuge impoundment database (i.e. RMAD or comparable tracking system).

2.1.18 Record all management actions implemented in each impoundment in the Refuge impoundment database (i.e. RMAD or comparable tracking system).

Objective 2.2 Impoundment Restoration for American Black Duck

By 2014, enhance or restore 100 acres of impoundments to meet the habitat needs of black ducks by conducting a habitat analysis to determine which impoundments best meet their feeding, loafing, and thermal requirements, and which impoundment (s) could be enhanced; plan/implement habitat restoration/enhancement on 1-2 impoundments using an Adaptive Management approach.

MANAGEMENT STRATEGIES:

2.2.1 Within 2 years of HMP completion, complete the habitat analysis of existing impoundments to identify 2-3 impoundments with the most potential to focus on for black duck habitat enhancement and restoration.

2.2.2 Within 2 years of HMP completion, contract a tidal wetland expert or a hydrologist to design several alternative hydrologic models to restore Sow Pond, Ragged Point or F-Pool impoundment to salt marsh. In the case of F-Pool, removing the existing WCS and installing larger box culverts should be evaluated. For Sow and Ragged Point impoundments, partial or complete dike removal and muted vs. full tidal action scenarios should be considered.

2.2.3 Within 3 years of HMP completion, develop and implement an adaptive management experiment to flood encroaching myrtle and other encroaching woody vegetation in the impoundment with the most potential, based on Strategy 2.2.1 above.

2.2.4 Within 10 years of HMP completion, investigate the feasibility of restoring Lighthouse Meadow impoundment to a tidal salt marsh.

MONITORING STRATEGIES:

2.2.5 Continue monitoring for waterfowl, shorebirds, and waders on CNWR impoundments and adjacent tidal areas, as specified in the CNWR Inventory and Monitoring Plan, before and after restoration or enhancement actions.

2.2.6 Within 1 year of HMP completion, re-evaluate the observation points or protocol used in these weekly/bi-weekly surveys to determine if it can be improved to better detect waterfowl in flooded brushy habitat. The flooded wooded areas are not easily seen from current road survey points, so consider developing correction factors from supplemental walking or aerial counts (for example, VDGIF mid-winter surveys).

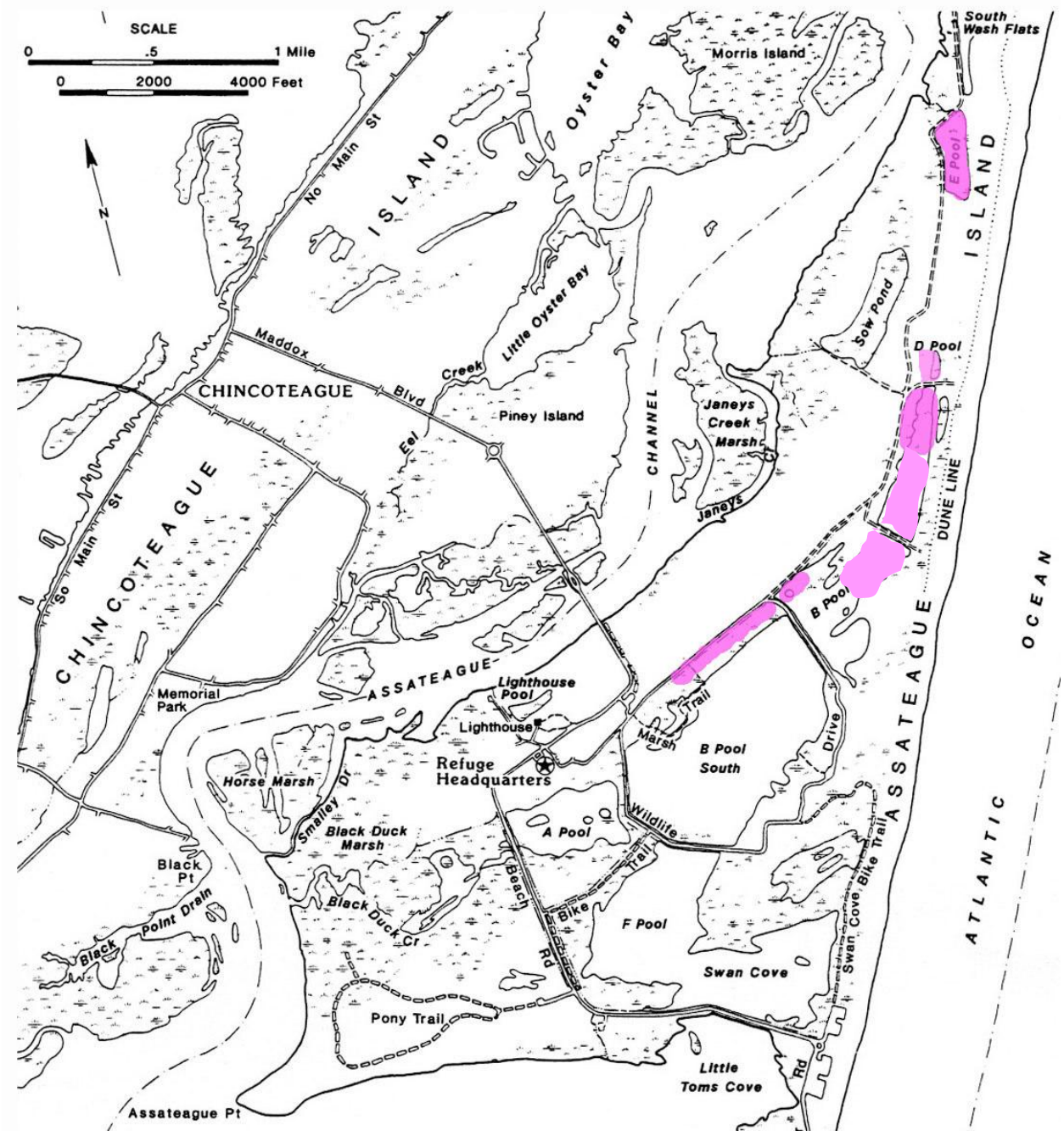
Objective 2.3 Impoundment Management for Monarch Butterflies

Manage at least 40 acres in the Impoundments Unit (bottoms of impoundments) each fall, through water-level manipulation and mechanical treatment, with the goal of providing 50% cover of *Bidens laevis* **(**or other favored nectaring plants) on these 40 acres during peak monarch migration (mid-September through mid-October). Defer mowing of any *Bidens* flowering on dike edges until after November 1 or seed set.

MANAGEMENT STRATEGIES:

2.3.1 Encourage the growth of *Bidens laevis* on impoundment bottoms and borrow ditches. Conduct mechanical treatments (disking, mowing) and prescribed burning in impoundments B-South, B-North, C-Pool, D-Pool and E-Pool on a rotational basis so that at least 50% of the *Bidens laevis* stands (Figure 12) are in flower September-October in a minimum of 2 of these

Figure 12 ***Bidens laevis*** **Locations (shaded) in Impoundments (from Gibbs 2008)**



impoundments. Avoid mowing or disking any areas with *Phragmites* because it spreads this invasive.

2.3.2 Adjust the timing of *Phragmites* aerial spraying so that it is completed prior to September 10th to avoid overspray and wind-drift onto goldenrod, *Bidens laevis*, and other nectar plants.

2.3.3 Delay fall mowing of other monarch nectaring plants on dike tops and slopes until after November 1.

2.3.4 Collaborate with Ms. Gibbs' greenhouse germination experiments of *Bidens laevis*, and other nectar plants if appropriate, by collecting seeds for propagation.

MONITORING STRATEGIES:

2.3.1 Success in meeting the *Bidens* cover objective will be measured in conjunction with Monitoring Strategy 2.1.15 and 2.1.16 for assessing broader impoundment vegetation management objectives.

2.3.2 Encourage volunteers, groups, and outside researchers to conduct monitoring and research studies of monarchs on Chincoteague during migration.

2.3.3 Contribute to data collection and collation identified in the North American Monarch Conservation Plan (Commission for Environmental Cooperation 2008).

Objective 2.4 Artificial Nesting Structures

Annually maintain 35 nest boxes located in or adjacent to impoundments for tree swallows as a volunteer service project. Discontinue maintaining wood duck nest boxes.

MANAGEMENT STRATEGIES:

2.4.1 Encourage the October Road Scholars (formerly Service Elderhostel) group to continue maintaining (checking for use, cleaning, and repairing) approximately 35 tree swallow boxes.

2.4.2 Use a volunteer group from an organization such as The Nature Conservancy Nassawango Creek Preserve to remove and recycle the wood duck nest boxes.

MONITORING STRATEGIES:

2.4.3 The volunteer group maintaining swallow boxes will record which boxes were used and the nesting species. Refuge biology staff will track the box occupancy rate and data sheets.

5.3 Goal 3. Upland Habitats

Objective 3.1 Shrub Habitat for Breeding and Migrating Landbirds

Maintain 2,500 acres of coastal shrubland dominated by wax myrtle, bayberry, and groundsel to provide forage and cover habitat for fall landbird migrants, and breeding, and wintering landbirds. One hundred percent of this habitat should be native species, at least 50% of which should be fruit-bearing shrubs averaging 3 meters in height and contain few or no pine trees. Where site conditions allow, maintain and/or restore a continuous band of this habitat, 300 feet or more in width, between impoundments and the dune line.

MANAGEMENT STRATEGIES:

3.1.1. Manage 500' wide continuous strip of 3-3.5 meter tall myrtle/bayberry shrub, free of trees, parallel to (and behind the) dunes on eastern side of the South Wash Flats impoundment. This

is a preliminary width based on data from Roberts 2009 and personal communications with the author.

3.1.2. Within 5 years of HMP completion, refine Strategy 3.1.1 using a combination of ground reconnaissance, aerial photos, and GIS to identify and map additional areas on the eastern side of other impoundments (i.e., behind the dune line), where a 3-3.5 tall myrtle/bayberry shrub will be maintained by various vegetation management techniques.

3.1.3. Use a hydroaxe or chainsaw to selectively remove loblolly pine trees ≥2 meter tall where they are encroaching in otherwise suitable myrtle/bayberry habitat on impoundment edges.

3.1.4. Carefully manage the encroachment of woody shrubs around the edges of the impoundments around Wildlife Loop (B-Pool, F-Pool, A-Pool) to achieve multiple objectives of providing waterbird habitat and wildlife viewing, while maintaining habitat for wintering sparrows. Mow on a rotational basis, leaving at least 50% of the brushy vegetation around the perimeter of these impoundments un-mowed in any given winter by following the prescriptions illustrated in Figure 13 below:
"A" Prescription= Mow alternate sides of the road in these areas in any given year, and at least one of the "A" areas will remain un-mowed in any given winter.
"B" Prescription= Mow this area in alternate years as the "A" Areas.

3.1.5. Through hunting, maintain the sika elk and white-tailed deer population, at levels low enough so as not to degrade the shrub vegetation by over-browsing. The present season: a two-week sika/deer archery season in October, a one-week sika/deer firearms season in early December, and a 3-week firearms sika only season in mid-December and January is currently fulfilling this objective. Depending on the elk/deer population and/or hunter participation, this season may be expanded or contracted in the future.

MONITORING STRATEGIES:

3.1.6 Within 5 years of HMP implementation, analyze the 10-year data set (1996-2006) from the Breeding Bird Survey (BBS) routes conducted in Refuge shrub and forest habitats. Determine trends of prairie warbler, brown thrasher, northern bobwhite, field sparrow, and other breeding landbirds of Highest, High, or Medium conservation concern on the BCR 30 list (Appendix 1), analyzing results in the context of other BBS routes in the Region. Use this analysis to develop additional habitat management actions to benefit these species.

3.1.7 In conjunction with Strategy 3.4.6 to update the Refuge's vegetation cover map, plot BBS route survey points on the cover map. Use this spatial analysis, together with results from Strategy 3.1.6, to determine how frequently the Refuge's BBS routes should be repeated, and whether additional routes should be added.

3.1.8 Continue to partner with volunteer Dr. Dick Roberts, and other individuals or organizations as opportunities arise, to increase our understanding of how breeding and migrating landbirds use Refuge habitats through banding and other monitoring projects. Specifically, encourage Dr. Roberts to set up a mist-netting banding site in myrtle/bayberry shrub on east side of South Wash Flats to monitor breeding prairie warbler, brown thrasher, field sparrow, and other landbirds of conservation concern (Appendix 1).

3.1.9 Within 5 years of plan implementation assess whether elements of the R5 Migrating Landbird Study can be incorporated into Refuge monitoring strategies.

Figure 13 Mowing Prescription for Winter Sparrows: Wildlife Loop

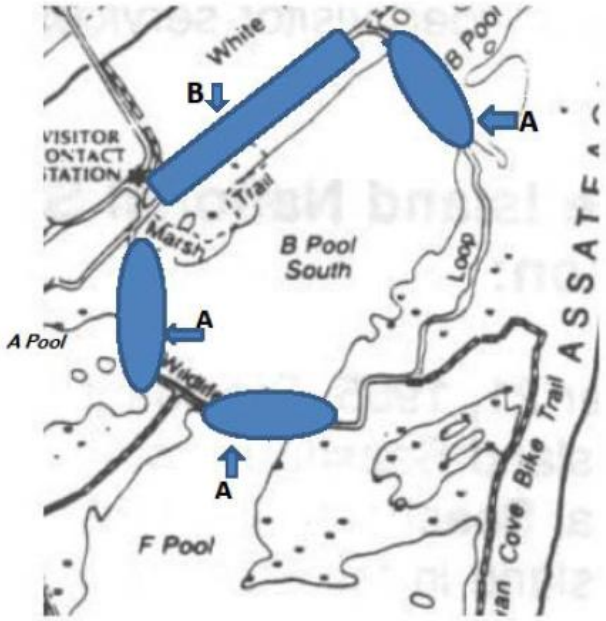
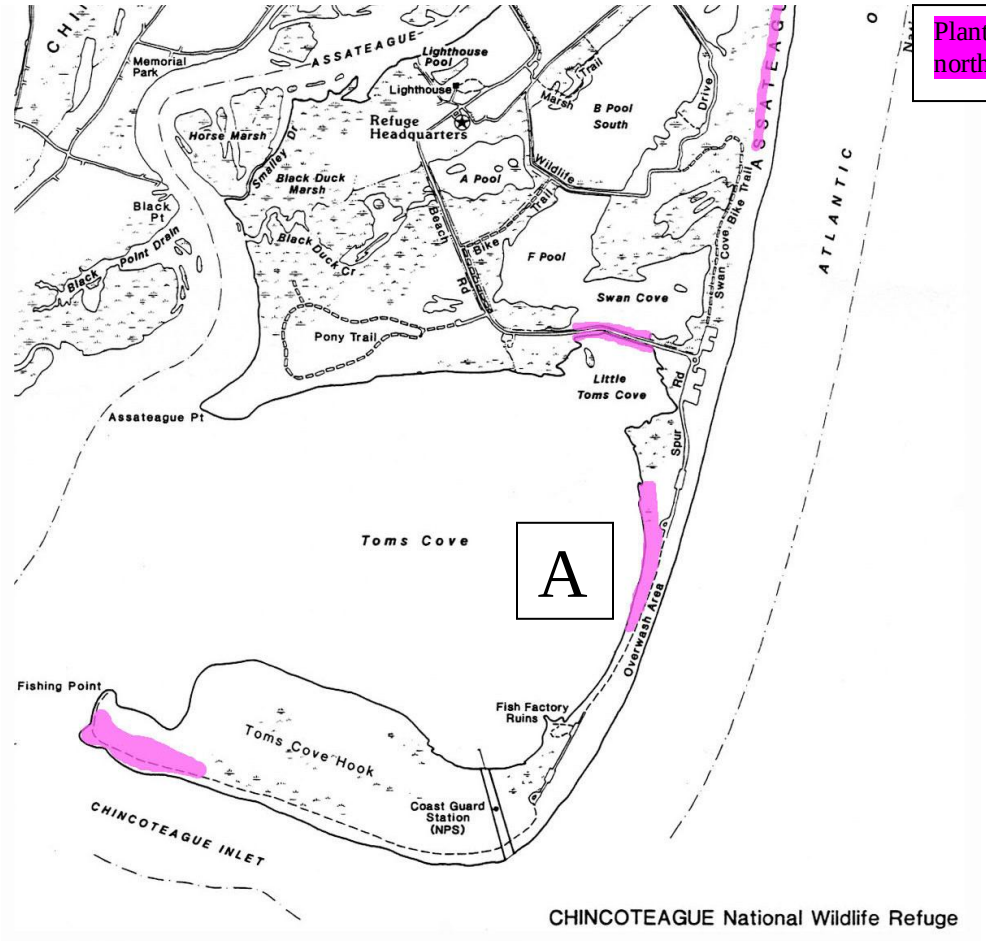


Figure 14 Suitable Seaside Goldenrod Planting Locations on Assateague Island (from Gibbs 2008)



3.1.10 Continue to collaborate with VDGIF and NPS to annually estimate sika and white-tailed deer population size and structure on Assateague from deer hunt check station data and other information as appropriate.

Objective 3.2 Roosting and Nectar Source Habitats for Monarch Butterflies

Maintain, through rotational mowing, a minimum of 80% of the reliable monarch roosting locations and 50% of the preferred nectar source locations (Figure 9) in an unaltered state during the migration period (mid-September through mid-October) in any given year. Restore and enhance preferred nectaring plants (seaside goldenrod, *Bidens laevis)* in areas where they already grow or other suitable areas. Roosting habitat is defined as thickets of bayberry, groundsel-tree, black cherry, marsh elder, or red cedar with an eastern exposure of a patch size sufficient to buffer winds adjacent to large open areas such as north side of Toms Cove and western side of impoundments.

MANAGEMENT STRATEGIES:

3.2.1 Delay mowing, on rotational basis, monarch nectaring and roosting locations depicted on Figure 9 until after November 1 or seed-set (whichever is later) on at least 80% of the roost sites and 50% of the nectar sources.

3.2.2 Encourage interested cooperator(s), such as Denise Gibbs, to periodically (every 3-5 years) reassess important monarch roosting and nectar locations. The dynamic nature of barrier island systems is expected to alter some of the monarch habitat shown on Figure 9, so monarch habitat protection and management actions will need to be dynamic as well.

3.2.3 Continue the partnership with monarch researcher Denise Gibbs whereby Refuge volunteers collect seaside goldenrod seeds in November for propagation by Ms. Gibbs, and seedlings are planted the following spring or fall.

3.2.4 Plant seaside goldenrod seedlings in spring or fall using volunteers, as opportunities arise, on small dunes that dot the Overwash area, the north end of Toms Cove (including the causeway west of the NPS TC Visitor Center), and the backsides of dunes along Wild Beach (Figure 14). Planting should occur on no greater than 5% of the Overwash area so as not to conflict with beach nesting birds which prefer open un-vegetated beaches and shell flats.

MONITORING STRATEGIES:

3.2.5 Encourage cooperators and volunteers to monitor monarch migration on the Refuge through monarchwatch.org or other cooperative efforts outlined in the North American Monarch Conservation Plan (Commission for Environmental Cooperation 2008).

Objective 3.3 Roadsides and Dikes for Squirrel, Monarchs and Nesting Birds

Manage mowing on Refuge roadsides, cross-dikes and fence lines in order to minimize Delmarva fox squirrel vehicle mortality at 5 or fewer squirrels per year, and maximize nesting opportunities for northern bobwhite and brown thrasher. Height of roadside vegetation along Beach Road west of the Pony Coral will be maintained at ≤ 6 inches. Mowing of other roads, trails, dikes will be confined to the non-growing season: November 1 – April 1, except where there are over-riding needs to protect public safety or wildlife species.

MANAGEMENT STRATEGIES:

3.3.1 Mow a 10-12 foot wide swath along each side of Beach Road between Assateague Channel Bridge and the Pony Corral as needed during the growing season to maintain vegetation height at ≤ 6 inches, in order to minimize Delmarva fox squirrel (DFS) vehicle strikes.

3.3.2 Mowing on Beach Road from Pony Coral to Toms Cove VC will be minimized in order to protect goldenrod and other butterfly nectar plants. Mowing will occur only if needed for safety reasons; and only then will grass on the road side of the wooden posts be trimmed so wooden posts are visible to motorists. Care will be taken by maintenance crew during mowing so that vegetation behind posts is left uncut for the entire growing season, allowing goldenrod plants to seed and spread. Mowing to control woody vegetation will not take place until after November 1.

3.3.3 Service Road: Mow a strip no wider than 5-feet along the road edge during the growing season to minimize DFS vehicle strikes and for maintenance of road bed. A wider swath may be mowed between November 1 and April 1 to prevent woody encroachment.

3.3.4 Wildlife Loop: Mow a strip no wider than 5-feet on either side of the road around the perimeter, with minimal mowing around benches and viewing spots. Primarily for public health and safety reasons, keeping roadside grass low allows pedestrians and bicyclers to step off the road with less concern for ticks and chiggers. Dikes may be mowed between November 1 and April 1 to prevent woody encroachment and maintain wildlife viewing opportunities.

3.3.5 Woodland Trail generally will not be mowed, except to facilitate public enjoyment of kiosks, benches, and trails.

3.3.6 Impoundment dikes such as D-Dike, C-Dike, etc.: Mow as needed to prevent woody encroachment. During the growing season mow a 10-foot wide strip on the top of dike, providing un-mowed habitat on slopes and toes of dike for ground nesting birds and monarch nectar plants. Slopes and toes of dike will be mowed early in November to reduce woody encroachment but prevent waterfowl disturbance.

3.3.7 Pony Fences: Mow only as wide as needed to facilitate inspection and repair of fences and prevent woody plants and vines from strangling the fence. Generally, this will be a swath no more than 6-7 feet wide on either side of the fence. In areas where brush or tree limbs need to be trimmed back to a distance >7 feet from the fence to ensure the safety of equipment operators, maintenance and biology staffs will coordinate to flag or otherwise mark the areas prior to mowing. Mowing during the nesting season will be avoided, except where this is not possible (e.g., wet/muddy conditions). Combine with herbicide spraying to increase effectiveness.

MONITORING STRATEGIES:

3.3.8 Continue to record (including sex and age) all DFS killed by vehicle strikes and inspect them for PIT tags to determine whether road killed DFS remain below 5 per year.

Objective 3.4 Forested Uplands for DFS, Brown-headed Nuthatch & Eastern Towhee

Diversify the structure and age-class of 1,600 acres of predominantly mature loblolly pine forest on Assateague Island to create habitat conditions favorable to support a minimum population of 200 Delmarva fox squirrels, and breeding habitat for brown-headed nuthatch and eastern towhee. Manage

natural disease outbreaks to create younger class stands that vary in size between two and ten acres, and favor regeneration of hardwoods. Within three years of plan implementation, thin 50 acres of young, overstocked, monotypic stands of loblolly that have no shrub or hardwood understory. Also during the first five years of plan implementation, develop silvicultural prescriptions to create small openings in the forest that will increase the hardwood component.

MANAGEMENT STRATEGIES:

3.4.1 Continue to regularly scout for natural southern pine beetle (SPB) outbreaks, focusing the most effort during conditions when the SPB is most active: spring and fall when daily temperatures are between 60-80º F. Scout weekly during these conditions. During periods of successive drought, or other physiological stress, conduct aerial surveys, especially in mid-summer. When SPB beetle infested tree(s) are discovered, mark individual tree(s) and/or GPS the perimeter of the infestation and monitor for spread of the disease at least monthly. Identify and map natural barriers to the SPB such as non-pine vegetation, young pine stands, roads, water, etc.

3.4.2 If a SPB outbreak spreads to cover a single block of five contiguous acres in one growing season, assess whether management actions are needed to control the infestation so that it can be contained within a 10-acre or less block (Cherry Keller, USFWS DFS Recovery Coordinator, pers. comm.). Each situation will need to be evaluated on a case-by-case basis to determine rate of spread and whether natural barriers will contain the outbreak to a size that does not impact DFS, public safety, or other important resources. If suppression action is determined necessary, the preferred method will be to cut all currently infested pine trees in addition to a green tree buffer of at least the average stand tree height in front of the leading edge or head of the outbreak during the April-October growing season (Paul Merten, USDA Entomologist, pers. comm.)[7]. Green and infested trees within the buffer will be felled so they fall in the direction of the infected zone and can be left on the ground.[8] Vacated (those with numerous beetle exit holes or with sloughing bark) should be left standing as they provide habitat for the checkered beetle, and other native biological control insects of SPB (Merten, pers. comm.). Standing dead trees no longer harbor SPB and provide snag habitat for birds and squirrels. Leaving dead trees also minimizes disturbance to wildlife habitat, and may also promote the growth of hardwood trees in the understory. Hardwoods are not affected by SPB, but are often damaged by clear-cutting methods to remove infested pine trees.

3.4.3 Perform early detection and rapid response to control invasive, undesirable plants and animal species. Continue managing the sika elk through hunting as described in Strategy 3.1.5.

3.4.4 Thin overstocked, young, monotypic loblolly pine stands ("pure pine" habitat type) in the Woodland Trail compartment and along Wildlife Loop by mechanical means and/or the use of prescribed fire. Thin to the area's Site Index (70 for CNWR), meaning 70 square feet of loblolly pine per acre. Time thinning so that it occurs when cones are green, to avoid spreading mature seeds.

[7] Width of green felled buffer is based on the formula: 10 tree widths X average height of the trees, and will be adjusted to the site. Felling trees during the growing season is important because hot ambient temperatures kill SPB.
[8] Fell and leave is a cost-effective control method because it removes the tall vertical search image SPB key on, and because the pheromone odor plume emitted to attract other SPB doesn't move when trees are flat on the ground; the fell and leave method should be done during the growing season to heat the logs (Merten, pers. comm.). Fell and remove is an alternate method that can be used at any time of year; the logs are treated at the sawmill to kill any SPB (Merten, pers. comm.).

3.4.5 Within 3 years of HMP completion, create an updated forest stand/compartment map using Continuous Forest Inventory (CFI) Procedures (Appendix 10b) developed by Chesapeake Marshlands NWR Complex Blackwater NWR, or comparable inventory method that takes into account wildlife variables. Use this map to develop management units for prescribed fire, stand thinning, and honing response to SPB outbreaks.

3.4.6 Within 2 years, update the vegetation cover map for Assateague Island (last updated in 1994).

3.4.7 Within 5 years, develop a Forest Management Plan that integrates the results of the CFI (Strategy 3.4.5), includes silvicultural prescriptions to enhance the hardwood component and enhances habitat for focal species, and incorporates relevant management actions outlined in the 1992 Upland Habitat Management Plan (CNWR 1992; see also Appendix 10a)

3.4.8 Within 7 years, implement a silvicultural prescription on a 100-150 acre block of mature forest that creates small openings, totaling no more than 25 acres of the block, and aims to increase the hardwood component and diversify the structure and age-class of loblolly forest.

3.4.9 If supported by the Forest Management Plan (Strategy 3.4.7) and CFI (3.4.5), conduct another prescribed burn in "pure pine" forest habitat, following recommendations by Kulynycz (2004). The prescribed burn unit should be planned to avoid the "loblolly pine/mixed hardwood" habitat and maritime forest. The burn would be conducted in late spring/early summer, with the goal of creating a more open understory and increasing structural diversity. If the prescribed burn has the desired effect of creating habitat conditions favored by forest focal species, additional burns could be considered for other areas.

3.4.10 Protect DFS from hunting, competition and predation by continuing to prohibit pets on Assateague Island, remove all feral cats, and reduce numbers of red fox (Strategy1.1.2). Trap and remove gray squirrels.

3.4.11 In coordination with USFWS Ecological Services and recommendations from the most recent status review, evaluate the need to maintain DFS nest boxes (the current number is 127). Decrease or eliminate boxes in favor of natural nesting cavities.

MONITORING STRATEGIES:

3.4.12 Continue to scout for natural SPB outbreaks (as described in 3.4.1 above) and invasive species when conducting the above ground surveys, and conduct aerial flights over Refuge as least bi-annually to detect dying trees and invasives that may be missed in ground surveys.

3.4.13 Conduct bi-annual population estimate of DFS population in White Hills, Lighthouse Ridge, and Woodland Trail areas using mark/re-capture methods.

3.4.14 Within 4 years of HMP implementation, conduct DFS population surveys in loblolly pine forest north of White Hills (i.e. Sow Pond, Ragged Point, Old Field areas) using Reconyx remote cameras, or other methods.

3.4.15 Prior to completion of the CCP, conduct a DFS population survey in Swan Cove area using mark/recapture, camera, or other methods in response to parking lot relocation options being considered in the Draft CCP.

3.4.16 Refer to Strategies 3.1.6 and 3.1.7 concerning BBS data analysis and resumption of Refuge BBS routes as these will also serve to monitor the response of brown-headed nuthatch and eastern towhee to forest objectives and management actions.

3.4.17 Conduct woodcock surveys on 3 of the 4 Refuge routes every three to five years. Due to the complete lack of detections and marginal habitat, drop the northern Service Road route from the survey. In years that surveys are conducted, conduct a minimum of two surveys: One prior to March 14 and one during the national survey period (April 10-30). Encourage a graduate student or other cooperator to investigate Assateague Island's importance for migrating and breeding woodcock. Woodcock was considered but eliminated as a focal species because it is thought that CNWR does not make a significant contribution to the population; however, this assumption has not been thoroughly investigated.

3.4.18 Within 5 years of HMP implementation, develop a simple monitoring protocol to estimate wild turkey population size and trends so that any proposal to begin hunting this game bird is based on biological data; preferably design a survey that can be conducted by volunteers. Although not a focal species, wild turkeys are a popular game species and increasing populations may bring increased interest for opening a hunting season.

Objective 3.5 Maritime Forest on Assateague Island

By 2015, delineate the boundaries of the maritime upland forest and maritime dune forest community types, and develop appropriate conservation measures.

MANAGEMENT STRATEGIES:

3.5.1 Using the community type descriptions in Fleming and Patterson (2010) and coastal maritime forest map for Accomack County in Berman and Berquist (2007) (Figure 10) as starting points, map the maritime forest on Assateague Island, and other areas on CNWR.

3.5.2 If any portions of the maritime forest type are found to be degraded, develop silvicultural or other forest management practices to restore its integrity.

Objective 3.6 Upland Habitats on Wallops Island NWR

Maintain and restore 178 acres of pine/mixed hardwood forest for the benefit of migrating/nesting landbirds, bobwhite, and woodcock. Working with partners such as A & N Electric Cooperative, reduce the number of acres occupied by invasive, non-native autumn olive from 75 to 40 acres by 2015, using mechanical and chemical means.

MANAGEMENT STRATEGIES:

3.6.1 Continue to support and build upon A & N Electric Cooperative's (ANEC) management of the right-of-way on Wallops NWR which favors maintenance of an early-successional plant community composed primarily of low-growing native shrubs such as dogwoods and warm-season grasses. ANEC plans to conduct the following actions (Mark Belknap, ANEC, pers. comm.) to manage their right-of-way:

- Mechanically (hydro-axe) remove tall-growing trees and shrubs, emphasizing the removal of autumn olive. Most mechanical work was completed in 2008, however from time to time tall dead, dying, leaning, or brittle trees along the right-of-way (ROW) border may need to be removed or topped.
- Selectively remove target growing trees/shrubs (red maple, pine, oak, sweet gum, dense raspberry) and all invasive species with herbicides and backpack sprayers in 2010, and

thereafter conduct chemical treatments at intervals of three years. Manage vegetation selectively for dogwoods, low-growing shrubs like bayberry that don't interfere with ROW maintenance, and grasses.

- Minimize use of heavy equipment in wetlands or other areas where vehicles will tear up the ground or create deep ruts. Use hand tools and backpack sprayers in these areas, or conduct activities in winter when the ground is frozen.
- Chemical application is usually planned for mid-late summer. Timing vegetation control activities for August or later will avoid impacts to breeding birds.
- Refuge staff will work with ANEC staff to select danger trees that could be topped to create brush piles that will be left in place for wildlife habitat.
- ANEC representative will coordinate with Refuge annually (target is March) to review vegetation management plans for the coming year, collect information to prepare Pesticide Use Proposals (PUP), and/or conduct a site visit to evaluate vegetation management.

3.6.2 Beginning in 2011, annually remove 5-10 acres of dense autumn olive stands by mechanical or chemical means, with the goal of eliminating the 25 acres of autumn olive-dominated stands by 2015.

3.6.3 With 3 years of HMP implementation, develop a plan and funding source to remove 52 acres of autumn olive intermixed in the understory of the pine/hardwood forest. "Basal bark treatment" with an oil-based herbicide applied to the bottom foot of individual trees during the winter is one possible technique. Consult with ANEC, Patuxent Research Refuge, TNC, and others experienced in removing this invasive tree to refine methods, a schedule, funding sources, etc.

3.6.4 Within 1 year of HMP implementation, treat 20 acres of *Phragmites* with herbicide using ground and/or aerial application. Conduct follow-up treatments at least bi-annually. This strategy will be reassessed and honed following completion of the Regional *Phragmites* SDM activity.

3.6.5 Within 7 years of HMP implementation, conduct a habitat assessment of the 57 acres of former agricultural fields to determine whether a portion of this area should be maintained in an early successional stage to provide bobwhite breeding habitat, in a patch size large enough to attract shrubland/grassland breeding birds. Breeding birds do not generally favor linear ROWs unless incorporated into a ≥10 hectare patch of suitable habitat (USFWS ____), so linking the ROW with one of the old fields could increase the value of both habitats for breeding birds.

3.6.6 Maintain wooded habitat on Wallops NWR that serves as a recharge area for Lucky Boy Fen.

3.6.7 Through hunting, maintain a sustainable white-tailed deer population that doesn't degrade the native understory vegetation by over-browsing or pose safety concerns to NASA Wallops Flight Facility or the VA Dept. of Transportation.

MONITORING STRATEGIES:

3.6.8 Within 5 years of HMP implementation, survey suitable habitat for northern bobwhite and American woodcock to determine their breeding and population status on WINWR

3.6.9 Within 10 years of HMP implementation, recruit a graduate student(s), volunteer, or other cooperator to investigate WINWR's importance to migrating and breeding landbirds and make management recommendations.

3.6.10 Repeat GPS ground mapping of invasive species' perimeter every 3 years. Scout for invasive species in conjunction with other management or survey activities.

3.6.11 ANEC will monitor vegetation objectives in the ROW by visual field observations every 1-2 years.

3.6.12 Within 3 years of HMP implementation, develop a simple monitoring protocol to estimate wild turkey population size and trends so that any proposal to begin hunting this game bird is based on biological data; preferably design a survey that can be conducted by volunteers. Although not a focal species, wild turkeys are a popular game species and turkey hunting may be proposed as an addition when the Refuge Hunt Plan is updated.

5.4 Goal 4. Southern Barrier Islands Unit

Objective 4.1 Habitat for breeding species: Assawoman, Metompkin, Cedar Island

Work with partners that manage other Virginia barrier islands to prevent human disturbance to nesting focal species (piping plover, least tern, and loggerhead sea turtle) on 4.3 linear km of Assawoman, 1.6 linear km of Metompkin, and 10.5 linear km of Cedar Island during the breeding season. Conduct management actions to minimize mortality and other disturbance factors.

MANAGEMENT STRATEGIES:

4.1.1 Work with partners (The Nature Conservancy, VDCR, VDGIF, etc.) to standardize public use regulations that reduce disturbance to nesting species on all Virginia barrier islands. This would include implementing standard operating procedures and consistent signing; directing recreation to less sensitive areas; and developing outreach materials and educational programs for the public. Until such a collaborative program is developed, the Refuge will implement the following strategies:

4.1.2 Continue to post the south end of Assawoman and the north end of Metompkin with "Area Closed" signs and rope. Conduct law enforcement patrols during the breeding season, focusing on the period when nests and chicks are present and visitor use is highest: Memorial Day through Labor Day.

4.1.3 Post important breeding colonies on Cedar Island with "Area Closed" signs.

4.1.4 Continue to minimize direct predation of piping plover, least tern, American oystercatcher, and other beach nesting birds through removal of mammalian and avian predators, and erecting nest exclosures as described in Strategy 1.1.2. Discourage nesting of gulls by egg-oiling, where feasible.

4.1.5 Protect any sea turtle nests on Assawoman, Metompkin, and Cedar Islands from human disturbance predators by erecting "closed area" signs as outlined in the Biological Opinion (USFWS 2008c), placing predator screens over all nests, and conducting mammalian and avian predator control as outlined in 4.1.4 above.

4.1.6 Prior to the 2011 breeding season, meet with the Commonwealth of Virginia, Marine Resources Division and Department of Conservation and Recreation (DCR) staffs to review ORV laws, regulations, and enforcement options for beach driving on Cedar Island.

4.1.7 Within three years following plan approval, survey and mark Refuge boundaries on Cedar Island, giving highest priority to conducting boundary surveys in areas with high densities of nesting birds.

4.1.8 Close Assawoman Island to all forms of public use, including fishing, during the breeding season (March 15 to August 31, or until all chicks fledge).

4.1.9 Maintain a Refuge staff presence on Assawoman, Metompkin, and Cedar of at least 3 days per week during the nesting season in order to enforce beach closures and educate the public about the need to minimize wildlife disturbance. At least one day should be on the weekend.

4.1.10 Collaborate with other barrier island managers and stakeholders to develop a "Virginia Barrier Island Public Use Management Plan" by 2013.

MONITORING STRATEGIES:

4.1.11 Continue to work with Virginia DCR to periodically obtain up-to-date aerial mapping of *Phragmites* on the southern barrier islands.

4.1.12 See Strategies 1.1.8, 1.1.9, 1.1.10, and 1.1.11 which summarize breeding shorebird and invasive species monitoring on all Refuge barrier islands.

4.1.13 Conduct sea turtle crawl and nest searches of Assawoman and Cedar Island beaches at least 3 times per week June through August, in conjunction with shorebird monitoring activities. Determine whether each sea turtle crawl resulted in a nest and monitor all confirmed nests for hatching and emergence as described in the Biological Opinion (USFWS 2008c).

Objective 4.2 Habitat for migrating and wintering species: Assawoman, Metompkin, Cedar Island

Over the next 15 years, preserve sandy beach and overwash habitat along on 4.3 linear km of Assawoman, 1.6 linear km of Metompkin, and 10.5 linear km of Cedar Island, and tidal marshes on the backside of the islands to benefit migrating and wintering focal species (red knot, sanderling, American oystercatcher, whimbrel), and other shorebirds of conservation concern.

MANAGEMENT STRATEGIES:

4.2.1 Within 3 years of HMP completion, gather and evaluate existing shorebird and waterfowl data (i.e., Christmas Bird Counts, mid-winter waterfowl surveys, or studies conducted by other partners) pertaining to islands in the Southern Barrier Islands Unit to identify key habitat use areas on Assawoman, Metompkin, and Cedar Islands for migrating/wintering red knots, American oystercatcher, sanderling, dunlin, whimbrel, American black duck, and other focal species.

4.2.2 Support research by partners aimed at fostering a better understanding of migrant and winter bird use of Assawoman, Metompkin, and Cedar Island. An example is the Center for Conservation Biology's red knot use of Barrier Islands study.

MONITORING STRATEGIES:

4.2.3 Annually conduct re-sight surveys for tagged red knots in fall and spring, as part of cooperative study, using protocols consistent with partners involved with red knot monitoring and research (see Strategy 4.2.2).

4.2.4 Continue to collaborate with partners on winter re-sight surveys for color-banded American oystercatchers in fall and winter. Currently, TNC and VDGIF survey roost sites around Metompkin, Assawoman, and Cedar, while the Refuge conducts winter roost re-sight surveys in Chincoteague Bay.

Objective 4.3 Maintain natural coastal processes and the integrity of natural habitats on Assawoman, Metompkin, and Cedar Islands

Allow and advocate for natural coastal processes as the primary force that shapes the southern barrier islands habitats and species composition.

MANAGEMENT STRATEGIES:

4.3.1 Continue to cooperate with DCR, TNC and others to control invasive plants on Assawoman, Metompkin, and Cedar. Conduct herbicide applications to Phragmites on at least a bi-annual basis until this invasive is contained, and thereafter conduct spot treatments.

4.3.2 Continue early detection and removal of Asiatic sand sedge (*Carex kobomugi*) and Beach Vitex (*Vitex rotundifolia)* on Assawoman Island. Work with NASA Wallops to remove the patch of Asiatic sand sedge on the south end of Wallops which has spread onto the Refuge.

4.3.3 Work with partners to obtain improved bathymetry data and vegetation cover mapping of the southern island units and seaside lagoons to better assess and plan for the impacts of sea level rise. A 2010 pilot project with NASA-WFF and TNC to acquire LiDAR mapping between Wallops and Metompkin Islands is one example.

4.3.4 Within 7 years of HMP implementation, conduct systematic search for seabeach amaranth on Cedar and Metompkin Islands in suitable habitat defined as sandy beach zone from 0.2 to 1.5 m above the mean high tide in overwash flats, blowouts, lower foredunes, and upper strands of non-eroding beaches. Focus survey on accreting portions of barrier islands that are sparsely vegetated with sea rocket (*Cakile edentula*) and seabeach spurge (*Chamaesyce polygonifola*), with which the species always co-occurs (Weakley and Bucher 1992).

4.3.5 Within 10 years of HMP implementation, conduct a feasibility study to see if a population of seabeach amaranth should be established on one or more of the southern island units through a transplant program. According to Weakley et al. (1996), islands longer than 5 km have the potential for supporting 2-3 sites, and islands shorter than 5 km can support one site. Using these guidelines, Assawoman Island appear to have conditions suitable for the establishment of 1-2 seabeach amaranth sites, and Cedar Island 2-3 sites.

MONITORING STRATEGIES:

4.3.6 Train all personnel conducting regular shorebird surveys on the identification of common native and potential non-native plants they may encounter, so that they can perform early detection and removal of invasive plants.

4.3.7 Conduct a coordinated survey for seabeach amaranth, Asiatic sand sedge, and beach vitex on Assawoman annually in late August/early September.

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Additional strategies outlined as part of the Comprehensive Conservation Plan (CCP) and environmental documentation (NEPA) process will be incorporated and implemented in this Habitat Management Plan.

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